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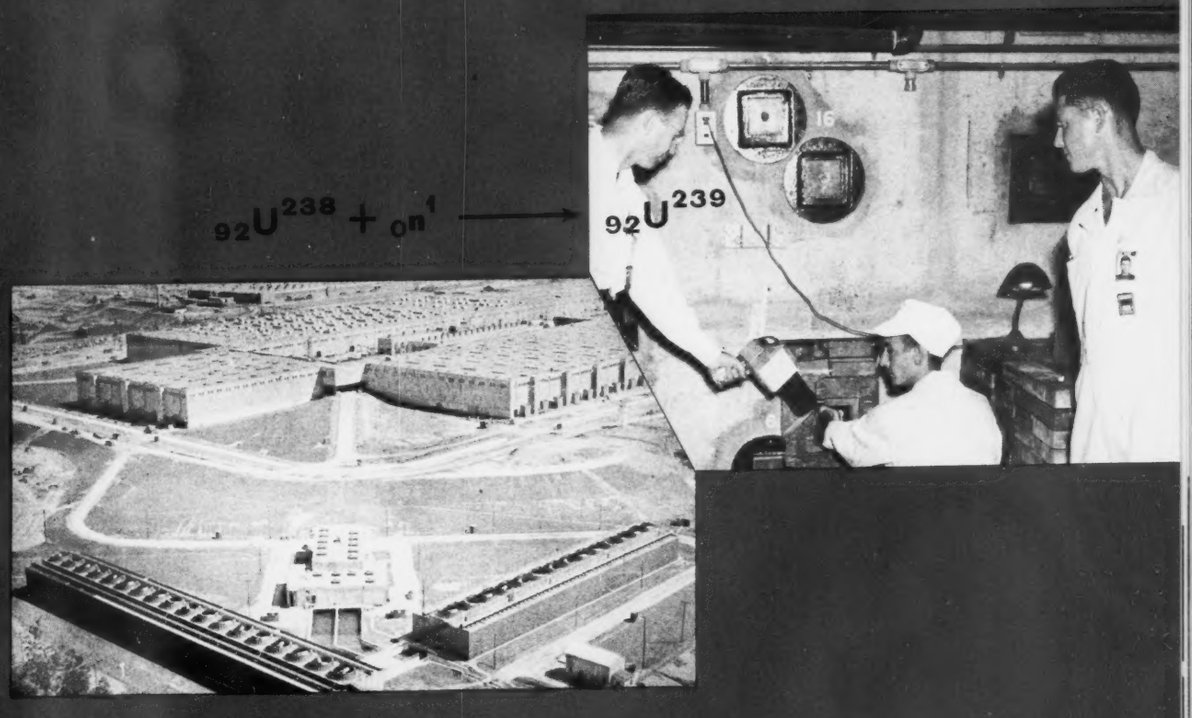

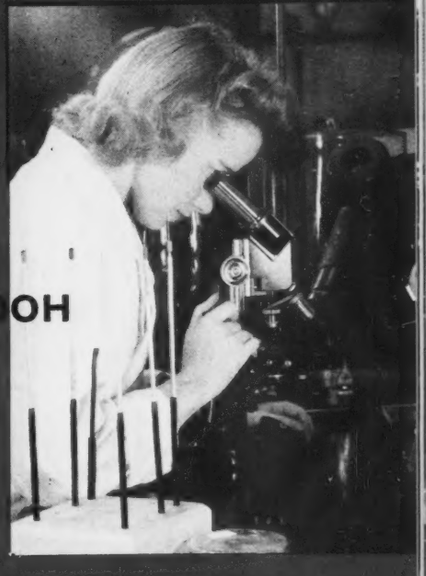

$CH_3\dot{C}OOH + CH_3COOH \longrightarrow CH_3\dot{C}OCH_2\dot{C}OOH$

december, 1947

A FEW NOTES TO REMEMBER

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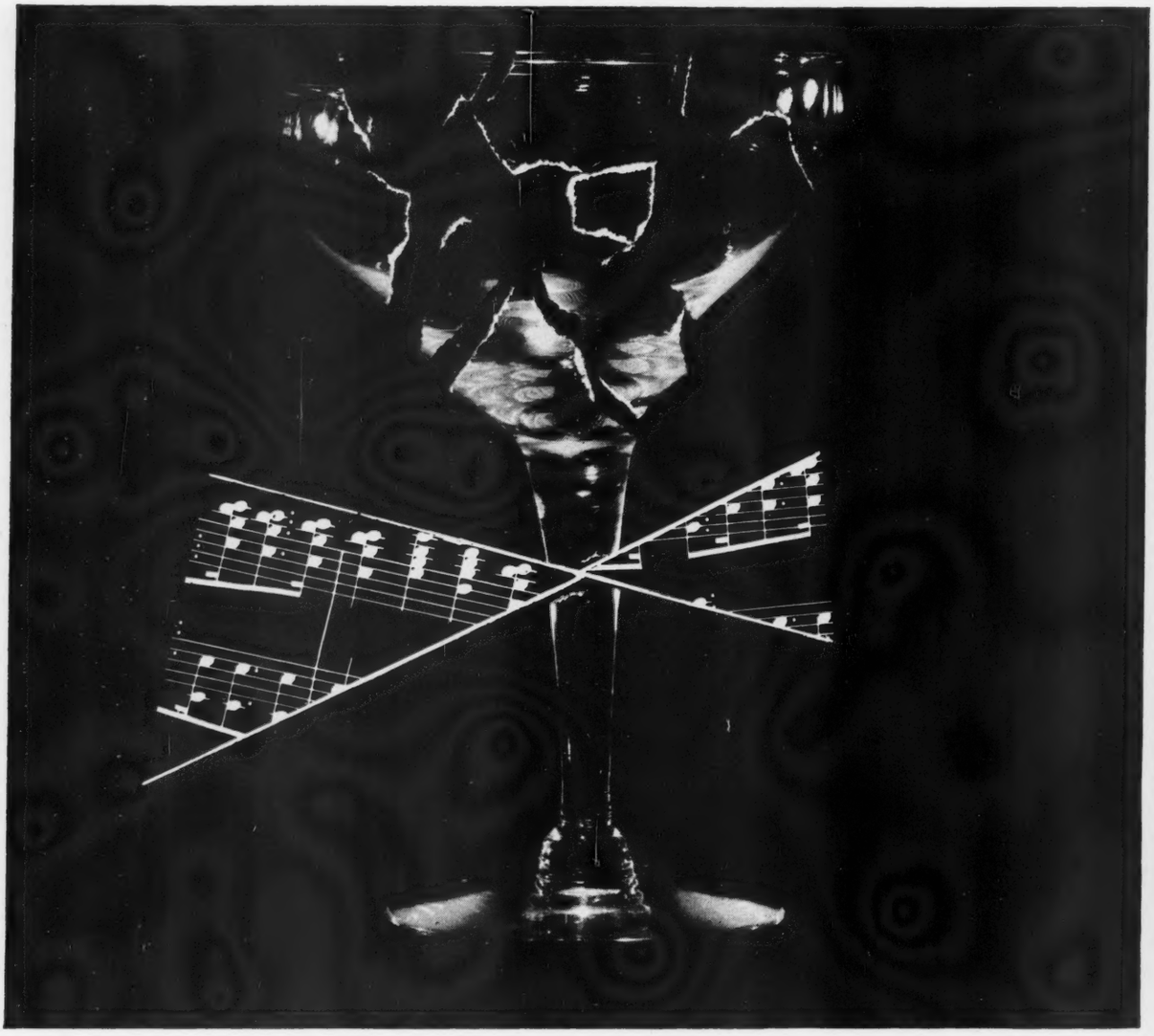

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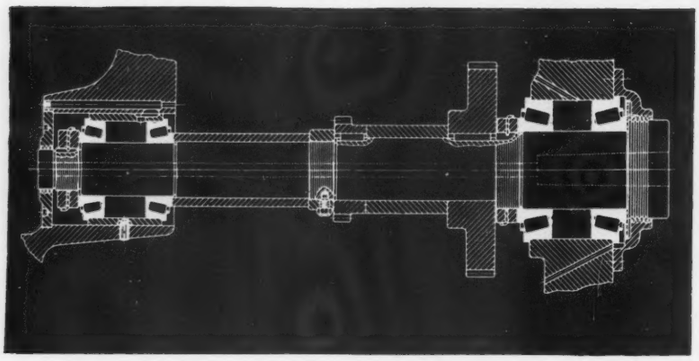
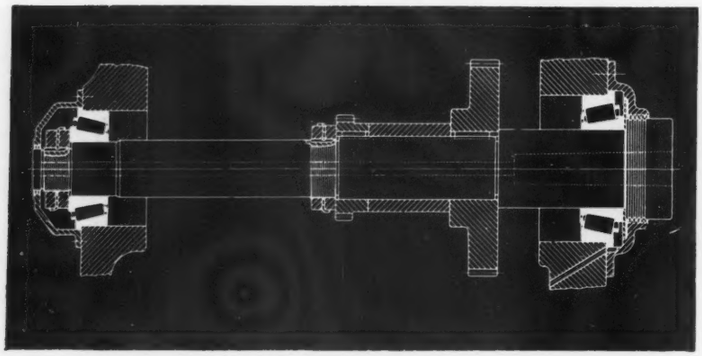
What Every Student Engineer Should Know About Bearing Functions

2.

HOW TO GET POSITIVE SHAFT ALIGNMENT—AND ELIMINATE COUNTERBORING OF BEARING HOUSINGS



MILLING MACHINE SPINDLE mounted on double flanged bearings front and rear. Rear bearings are carried in floating sleeve. Bearings are adjusted by means of double lock nuts and tongued washer.



MILLING MACHINE SPINDLE using single flanged bearings front and rear, the flanged bearings being used to permit through boring of the housing.

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BURLINGTON FIRST WITH VISTA-DOMES

Vista-Dome production line at the Budd Red Lion plant. In addition to the Burlington, Vista-Dome cars have been ordered by Chesapeake & Ohio, Denver & Rio Grande Western, Missouri Pacific and Western Pacific. Budd is prepared to construct Vista-Domes to meet any railroad's clearance requirements.

With the introduction of Vista-Dome cars in the Twin Cities Zephyrs, the Burlington has done a great service to American railroading.

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Congratulations to the Burlington for showing the way. Budd is indeed happy to have had a part in this important new development. The Budd Company, Philadelphia.

Budd

LIFETIME MAINTENANCE COST OF A RAILROAD CAR EXCEEDS ITS PURCHASE PRICE

Briefing the News . . .

The 200-inch Telescope Nears Completion

ON November 18, the biggest astronomical mirror on earth was carried from the California Institute of Technology, where it was ground and polished, to Palomar Mountain, 150 miles southeast, to become part of the new 200-inch telescope. This event climaxed nineteen years of effort on the part of scientists and technicians, during which six million dollars were invested in the project.

The 200-inch telescope was conceived by Dr. George Ellery Hale, who graduated from the Massachusetts Institute of Technology in 1890. One of the most distinguished of astronomers, he designed the great sixty and one-hundred-inch telescopes atop Mt. Wilson in California. Until now, the 100-inch instrument has been the world's largest telescope, but the new 200-inch telescope will penetrate twice as far into the cosmos, revealing objects a billion light years (6,000,000,000,000,000,000,000 miles) away.

After seven years of fruitless attempts to cast the great mirror, the present mirror was cast by the Corning Glass Co. A year was spent in cooling it at the rate of one degree a day. The mirror was then transported to the California Institute of Technology to be ground and polished for eleven years, until the mirror deviated from its desired curve, a perfect paraboloid, by less than a few millionths of an inch.

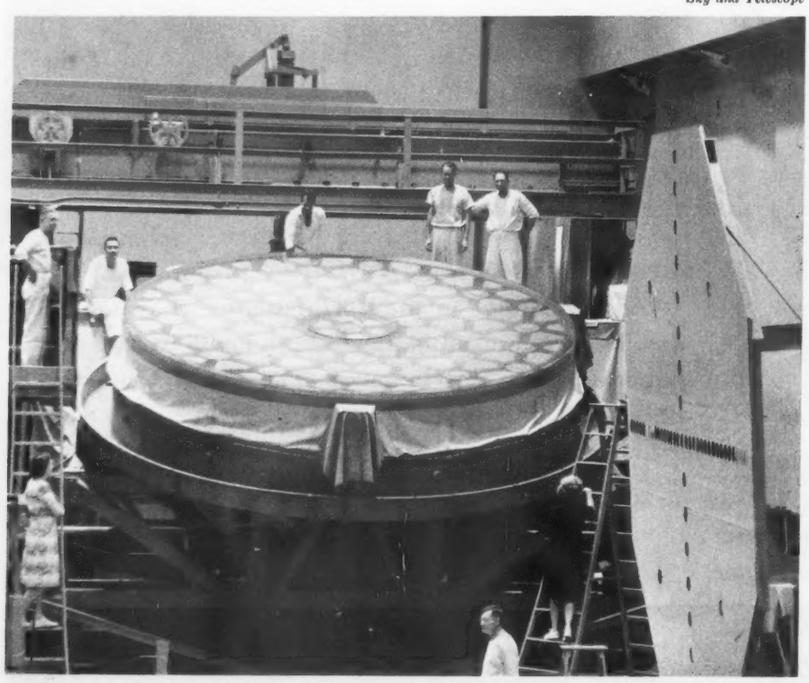
The seventeen-foot Pyrex-glass mirror is slightly concave, being two feet thick at the edge and about four inches thinner at the center. The mirror had an initial weight of twenty tons; after years of polishing with 34 tons of abrasives, however, it lost five tons in weight. The mirror was cast with its back in the form of a ribbed network, which has almost the same strength as solid glass and only half the weight.

As yet, the polished surface of the mirror has not received a reflecting coating. On top of Mt. Palomar this winter it will receive a spraying with aluminum metal, and then will be given a final polishing before being installed in the telescope mount. Early next summer the telescope is expected to be ready for use.

Many of the long-term problems of astronomers, such as the question of the existence of life on Mars, may be solved by the new instrument. With twice the diameter of the 100-inch telescope, the new telescope has twice the resolving power and four times as great a light-gathering power. Used in conjunction with a high-speed camera, it may be able to produce photographic evidence of the so-called "canals" on Mars, which may have been constructed by intelligent beings. The canals appear, to many astronomers, to be bordered by green strips, which change to brown during the Martian fall and winter. With the aid of a new photocell (*T. E. N.*, January, 1947), the Mt. Palomar astronomers may be able to analyze the infrared radiation given off by the green markings. If it checks with that of chlorophyll, the green coloring matter of plants, there will be strong evidence for the existence of plant life on the planet.

The 200-inch mirror before its trip to Mt. Palomar. Its ribbed back is visible through the glass

Sky and Telescope



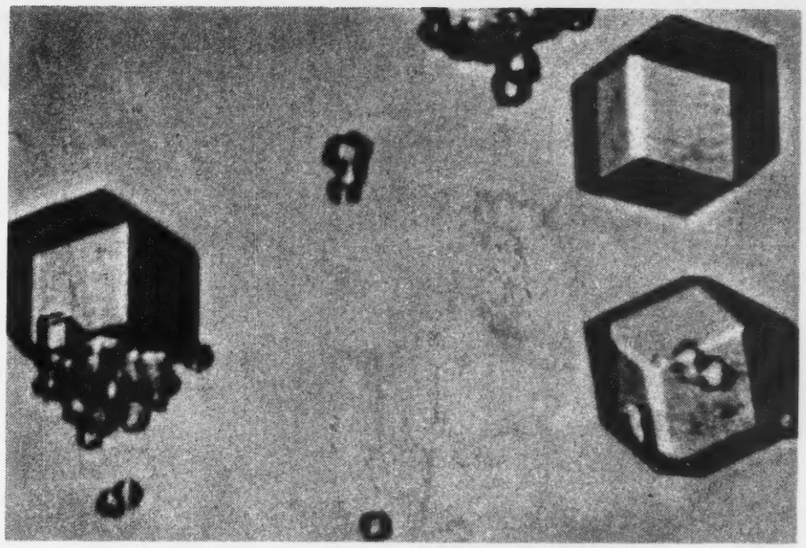
Chemistry and Life

Working in the never-never land on the border between chemistry and biology, the biochemists have been trying to break down the distinction between living and non-living matter by investigating the chemical reactions that accompany vital processes. A few weeks ago, Dr. Wendell M. Stanley of the Rockefeller Institute for Medical Research took a big step towards breaking down that barrier; by chemical means he had been able to change the characteristics of a virus and to cause these characteristics to be transmitted to its offspring.

The viruses are the most primitive of living organisms. Many of them are so small that they cannot be seen under an ordinary microscope. Under the electron microscope, however, they can be seen distinctly. They vary in size from about 10 to 300 millimicrons (10^{-7} centimeters), and vary in shape from spheres to slender rods. The dimensions of a typical virus (tobacco mosaic) correspond to that of a molecule having a molecular weight of 50,000,000. The viruses consist of protein material, since they can be broken down into amino acids, the building blocks of protein matter. Since the size of a virus corresponds to that of the higher molecular weight protein molecules, many biologists suspect that the virus is one giant molecule.

About a decade ago, Dr. Stanley, probably the world's foremost

biochemist, startled the scientific world by announcing that he had isolated the virus of the mosaic disease of tobacco plants in crystalline form. (*Tech Engineering News*, April, 1943.) He crushed the tissues of a tobacco plant infected with the disease, and filtered their suspension in water. The ultra-fine viruses passed through the pores of the filter along with the dissolved substances. Ammonium sulfate was added to the solution, and a precipitate containing the virus was formed. After subsequent dissolution and reprecipitation, the virus was obtained in the form of tiny needle-like crystals. The virus of another disease, bushy stunt disease, was obtained in tiny cubical crystals. The crystals were dried and stored in a bottle without apparent change. Then, when they were dissolved in water and again applied to a plant, the disease redeveloped.



W. M. Stanley and the Journal of Biological Chemistry

Crystals of the tomato bushy stunt virus (magnified 225 times)

That was where the matter stood on viruses until Dr. Stanley carried out his latest series of experiments. Deciding that viruses are giant protein molecules, Dr. Stanley undertook to alter them by adding or subtracting amino acid groups in the molecule. The viruses emerged from the treatment unharmed, but with greatly altered characteristics. Hardy virus strains became weak, and weak species became virulent. In one case, the virus transmitted its new characteristics to its descendants — thus establishing for the first time the alteration of heredity by chemical means.

Dr. Stanley hopes that his work may lead to methods whereby the hereditary makeup of higher organisms may be varied also. As Dr. Stanley points out, the genes which carry inherited characteristics from generation to generation in cell division may be giant proteins much like the viruses. If genes could be altered within the cell, or if altered genes could be added to a living cell, the possibility exists of varying the heredity of animals and plants. Such a process may take place in the body during the development of a cancer. Cancer cells are very similar to the cells of the tissue in which they develop, but nevertheless have distinctive characteristics which they pass on to the cells formed by their division. This view is supported by the fact that many coal-tar derivatives, such as methylcholanthrene, can cause the development of cancers.

New Radiation Tracers Found in Granite . . .

Studies conducted by Dr. Victor F. Hess at Fordham University have revealed that a hitherto unknown penetrating radiation emanating from granite, and possibly from most of the other rocks of the earth.

Experiments were carried out at a temporary laboratory set up in a New York subway, 160 feet below the surface, to screen out cosmic rays. The material used in the experiments was granite from Quincy, Mass., selected because of earlier studies to determine its content of uranium, radium, thorium and potassium, all of which possess a certain degree of radioactivity. The quantities of radioactive elements in the granite are extremely minute, yet their radiations can be accounted for accurately. However, radioactive measurements, Dr. Hess reported, revealed that the gamma rays, similar to X-rays, produced by the 300-pound sample of Quincy granite were 100 per cent greater than could be accounted for by the total quantities of the radioactive elements present.

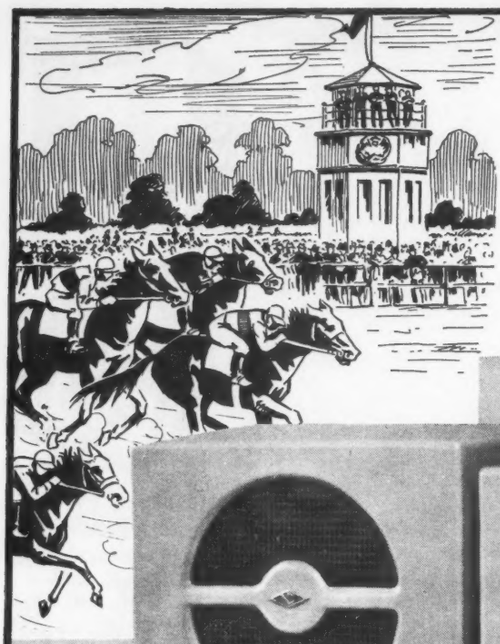
Experiments with South Carolina granite, a mineral containing almost no uranium, thorium, or potassium, showed a complete absence of any radiations from this type of rock. Therefore the unknown radiation is probably associated with these elements.

Dr. Hess and his associates are now concentrating their efforts on rechecking current data about the intensity of gamma radiation from potassium, since there is a chance that the radiation from potassium has been underestimated, and this may explain the unusual amount of radiation emanating from the New England granite.

New Elements . . .

Two new elements, numbers 61 and 96 in the periodic table, have lately been introduced to the world. Number 96, curium, was created by the atomic pile in 1945, but the element was not isolated until recently. Like all of the four known artificial elements, curium, the heaviest now known, is unstable. Each millionth of a gram shoots out seventy billion alpha particles per minute, three thousand times as many as the same amount of radium. Its half life, the time necessary for half of a given sample of curium to disintegrate, is only five minutes. For this reason, curium has never been found naturally, but can be synthesized by bombarding plutonium with alpha particles or americium with neutrons.

The other element, number 61, was recently synthesized and isolated by J. A. Marinsky and L. E. Glendien of the Massachusetts Institute of Technology, thus filling the last gap in the periodic table of elements. The two young nuclear chemists built up element 61 by bombarding element 60 (neodymium) with neutrons. They also extracted the missing element from miscellaneous fission products from the Oak Ridge pile.



ANOTHER NATIONAL

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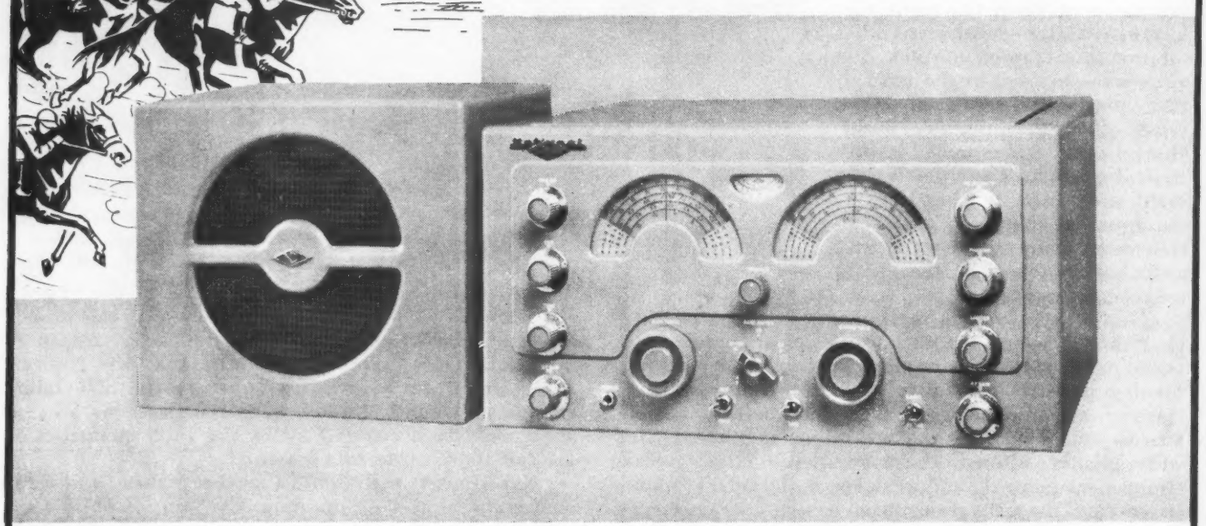
THE NC-183



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The TECH ENGINEERING NEWS

PROFESSIONAL JOURNAL OF THE UNDERGRADUATES

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Volume XXIX, No. 2

DECEMBER, 1947

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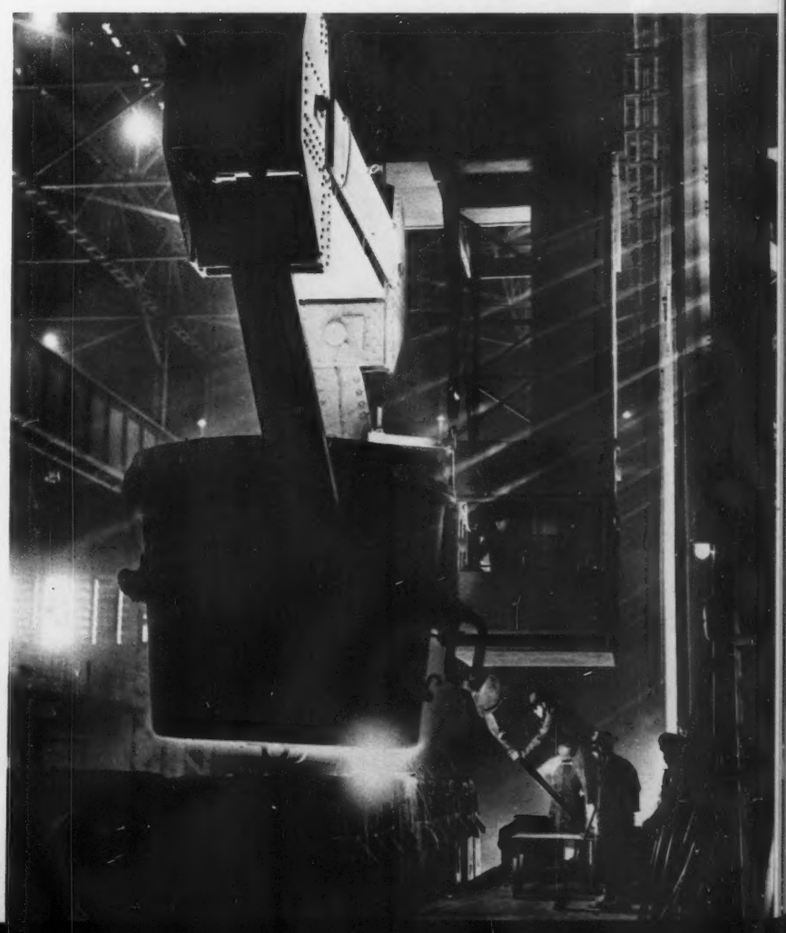

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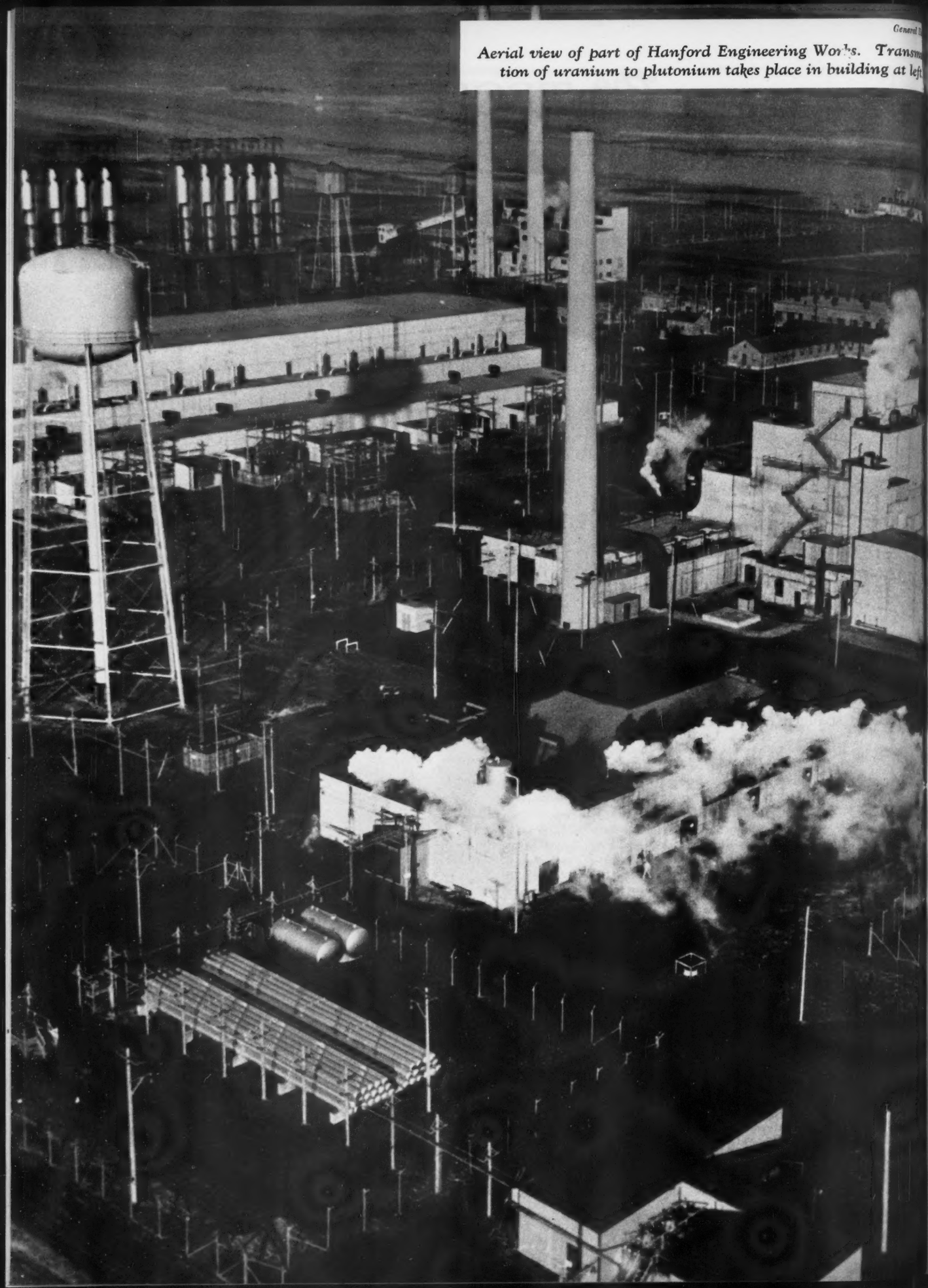


General E

Aerial view of part of Hanford Engineering Wo[illegible]*s. Transm*
tion of uranium to plutonium takes place in building at left

Tagged Molecules

By KENNETH KOPPLE, '51

EXPANDED facilities for the separation of isotopes of the lighter elements, coupled with the production made possible by the chain-reacting uranium pile, has given a strong impetus to biochemical research using "labeled" molecules. Since the isotopes used in this research, such as those of carbon, hydrogen and nitrogen, are available only in the form of pure elements or simple inorganic compounds, work with them requires synthesis into organic compounds readily assimilated by living cells. These syntheses include steps which nature has completed in the usual isotope-free organic compounds.

Before the time of isotopically "tagged" molecules, attempts were made to use molecules tagged chemically for tracing metabolic processes. A classic example is a study made of the metabolic oxidation of fatty acids.

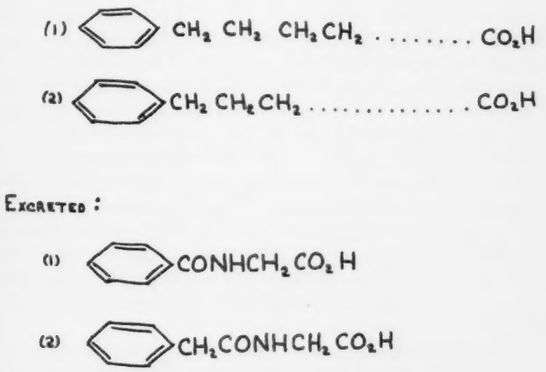
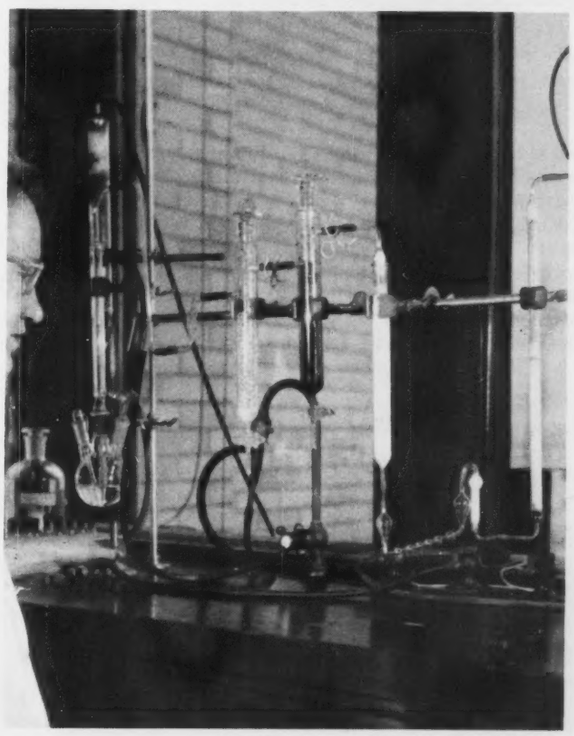


Figure 1. Metabolic oxidation of benzene-tagged fatty-acid analogs. The final oxidation product is combined with glycine in the body before excretion.

Through the use of benzene rings, which pass unaffected through the organism, fatty acids were traced from feeding to excretion. It was found that when acids similar to the natural fatty acids were attached to a benzene ring at one end of the molecule, the excreted products contained benzene tagged acetone bodies which were shorter by multiples of two carbon atoms than the compound originally introduced (Figure 1). From this evidence, it was deduced that fatty acids were oxidized at every second carbon atom except for the last four atoms which emerged as acetoacetic acid, a four carbon compound.

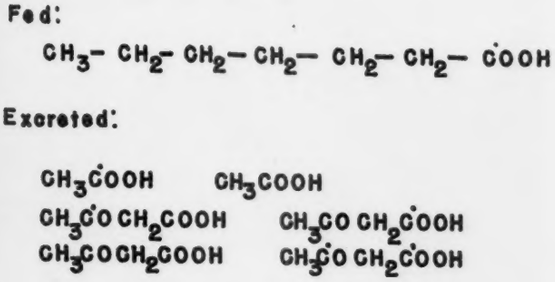
This method of tracing molecules has one important fault. Chemical labeling often produces such changes in the properties of molecules under study that the cells either react in an abnormal manner or do not act on the molecule at all. This failing caused some error in the example mentioned above. Chemical tagging can be used when it works, but it has the further disadvantage that it traces only the molecule as a whole. Isotopic tracing is capable of isolating individual atoms.



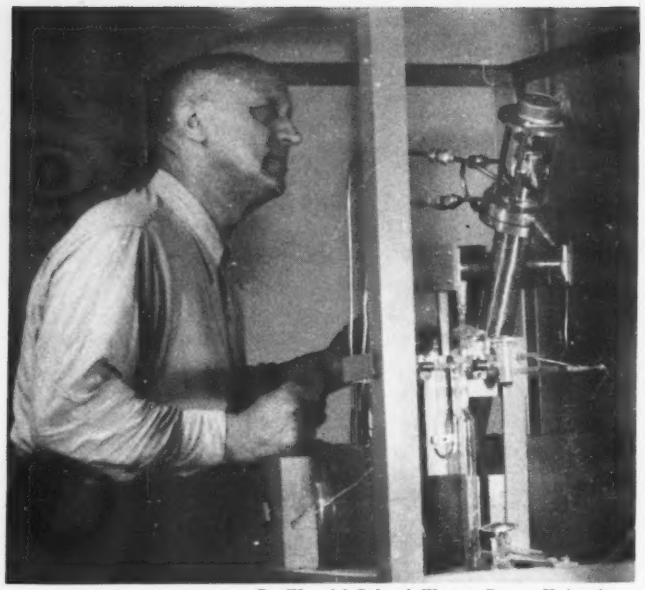
Dr. Warwick Sakami, Western Reserve University

The degradation of a sample of lactic acid labeled with C^{13}

Figure 2. Oxidation of tagged octanoic acid molecules in the body to acetic acid which partially recombines with itself to give the four possible acetoacetic acids.



The same problem in fatty acid metabolism studied by chemical tracing has been attacked with the aid of isotopically tagged molecules. An eight carbon acid, octanoic acid, which behaves just as the natural varieties, was synthesized with carbon 13, a stable isotope of carbon. The isotope was contained in the acidic end of the molecule (Figure 2). When the normal metabolic oxidation products — acetic and acetoacetic acids —



Dr. Warwick Sakami, Western Reserve University

A Western Reserve University scientist constructs a Nier-type mass spectrometer for the "tagged" molecules project.

were obtained they were examined with a mass spectrograph in order to trace the isotopic carbon. Atoms of carbon 13 were found to be distributed randomly among all the products, not just in the acid part of the acetic acid, as might be expected from the results of the previous work. These newer results tend to show that the fatty acid is completely broken down into two carbon units such as acetic acid and then partially recondensed to form acetoacetic acid.

Thus it can be seen that isotopic tracing of organic

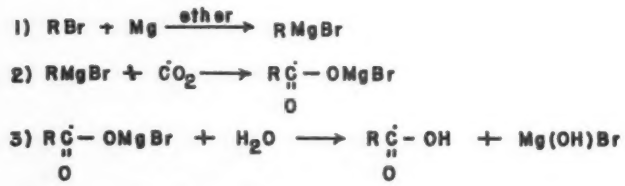


Figure 3. Use of the Grignard Reaction to introduce isotopic carbon into an organic compound. R is equivalent to almost any organic radical, either alkyl or aryl.

processes is one of the most accurate tools developed by the biochemist.

Isotopes are either stable or radioactive; both types are being used in research. The radioactive forms are easier to trace, but often allow little time for experimentation. As an example, carbon 11, a radioactive carbon isotope, is half decomposed in about twenty minutes. The stable isotopes, such as deuterium, heavy hydrogen, require more tedious tracing methods since there is no radiation which can be measured.

The radiation emitted by radioactive isotopes can be measured by the Geiger counter. This instrument, in brief, consists of a tube which carries an electrical discharge whenever a high-speed particle enters it and causes ionization. By measuring the frequency of these discharges, the amount of radioactivity in a sample can be determined. From this the amount of isotope present can be calculated.

To detect the stable isotopes, the mass spectrometer is used. This instrument separates atoms of different mass by deflection in an electromagnetic field. From the deposits of the various atoms (usually measured photographically) can be determined the amount of the tracing isotope present in the substance under examination.

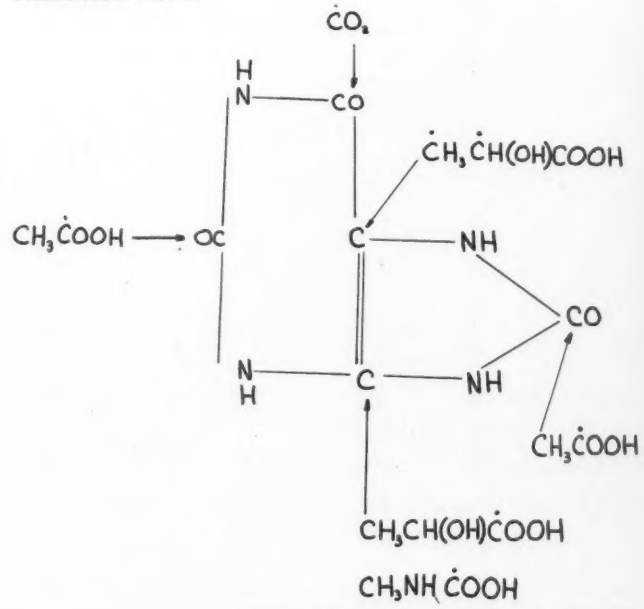
Tracing with Isotopic Carbon

There are three isotopes of carbon now used in biochemical research, discounting common carbon 12. Two of them, carbon 11 and carbon 14, are synthetic and radioactive and are now produced in the uranium pile. Produced from carbon 12, carbon 11 emits a positive electron of medium energy and can be detected with a Geiger counter. Carbon 14, produced from nitrogen, has a half-life of about fifty-one hundred years but requires a more sensitive type of counter, due to the low energy of its emitted electron. As available from the pile, these isotopes are in the form of carbonates. Carbon 13, a stable isotope of carbon, is present in about 1.1 per cent in all naturally occurring carbon and is concentrated by exchange between gases and liquids or thermal diffusion between gases. In these processes it is obtained as methane or the cyanide ion. None of these isotopes is produced in the pure form, but is mixed with normal carbon.

Production of compounds for use in biochemical research from the simple inorganic compounds in which the isotopes are available requires steps not usually found in organic syntheses. The Grignard reaction offers a simple example of such a step (Figure 3). An organic halogen compound, such as *n*-heptyl bromide, is reacted with magnesium turnings in the presence of anhydrous ether, producing heptylmagnesium bromide. When this compound is treated with carbon dioxide containing isotopic carbon, an addition compound is formed which can be hydrolyzed into a carboxylic acid containing one more carbon than the original molecule. This compound, which is octanoic acid when heptyl bromide is used, contains isotopic carbon in the carboxyl group. Such a synthesis, using carbon 13, was used in the previously mentioned studies on fatty acid oxidation.

This primary step can lead to the synthesis of many other isotope-containing compounds. The acids may be

Figure 4. The compounds which are the sources for the different carbon atoms in uric acid, a major product of human excretion, are indicated here.



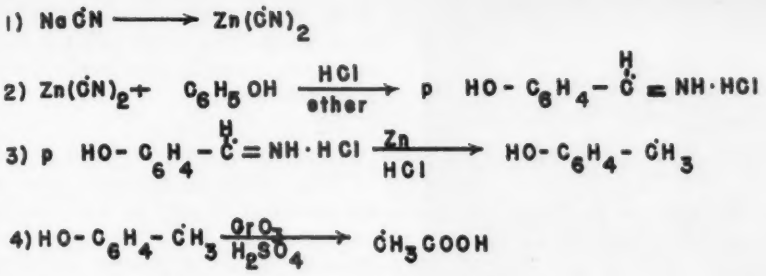


Figure 5. The synthesis of acetic acid with the isotopic carbon in the methyl group

condensed to ketonic compounds or reduced to hydrocarbons, alcohols or aldehydes. These compounds, in turn, can be used to produce other compounds, all with at least one atom of isotopic carbon in a known position.

A striking example of the use of such simple organic compounds in studies of body processes can be seen in a study made of the synthesis of uric acid by the organism. Pigeons, which, unlike mammals, excrete uric acid in place of urea as the end-product of nitrogenous metabolism, were fed 1-isotopic acetic acid, isotopic carbon dioxide, 1-isotopic lactic acid, 2, 3-isotopic lactic acid, and 1-isotopic glycine (an amino acid) (Figure 4).

By degradation of the excreted uric acid and locating the isotopic carbon in the whole molecule, researchers were able to trace the source of each atom of carbon in the uric acid molecule.

Such work as this gives important insight to the chemical processes which take place in the body.

The Grignard reaction produces organic acids with isotopic carbon in the carboxyl groups but cannot be used to make a compound such as 2-isotopic acetic acid. To do this, a more complicated procedure is necessary. Beginning with sodium cyanide, which can be produced from the inorganic isotopic compounds available, the synthesis consists of condensing phenol with zinc cyanide, the resulting hydroxybenzaldimine being reduced to toluol with isotopic carbon in the methyl group. This is strongly oxidized to give, among other products, acetic acid with an isotopic methyl carbon (Figure 5). From this product, other compounds can be synthesized with isotope in the methyl group instead of the carboxyl or carbonyl linkage.

Another interesting and important reaction, utilizing radioactive carbon 14, has been developed to produce methyl iodide with isotopic carbon. Barium carbonate, the available form of this isotope, is converted to carbon dioxide and then to potassium bicarbonate. This compound is reduced with hydrogen over a catalyst to give potassium formate. Methyl sulfate converts this to methyl formate which is reduced to isotopic methyl alcohol. Treatment with hydrogen iodide results in methyl

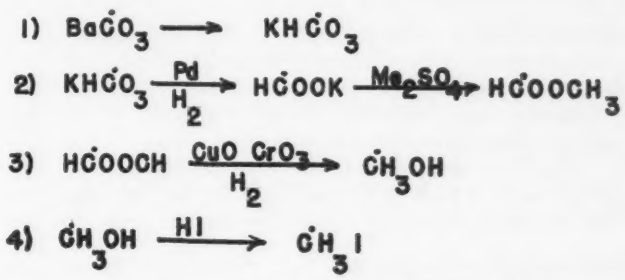
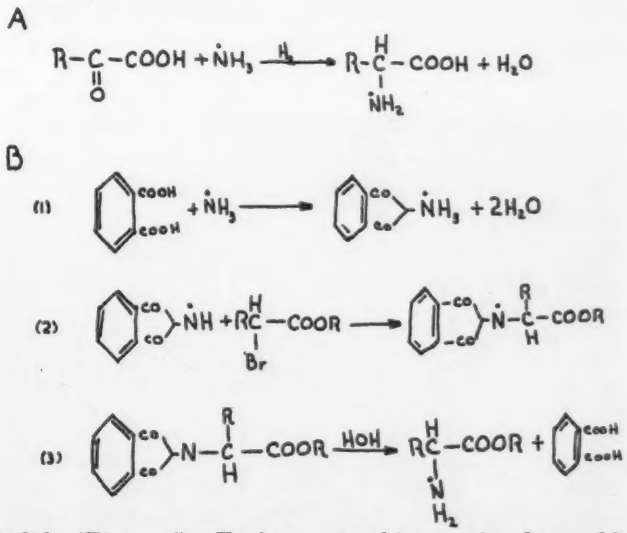


Figure 6. Synthesis of radioactive methyl iodide. Here, speed is the essential element

Figure 7. Syntheses of amino acids with isotopic nitrogen


A
R-C(=O)-COOH + NH3 H2 → R-CH(NH2)-COOH + H2O
B
(1) COOH COOH + NH3 → CO CO NH3 + 2H2O
(2) CO CO NH + RCH(Br)-COOR → -CO -CO N-CH(R)-COOR
(3) CO CO N-CH(R)-COOR HOH → RCH(NH2)-COOR + COOH COOH

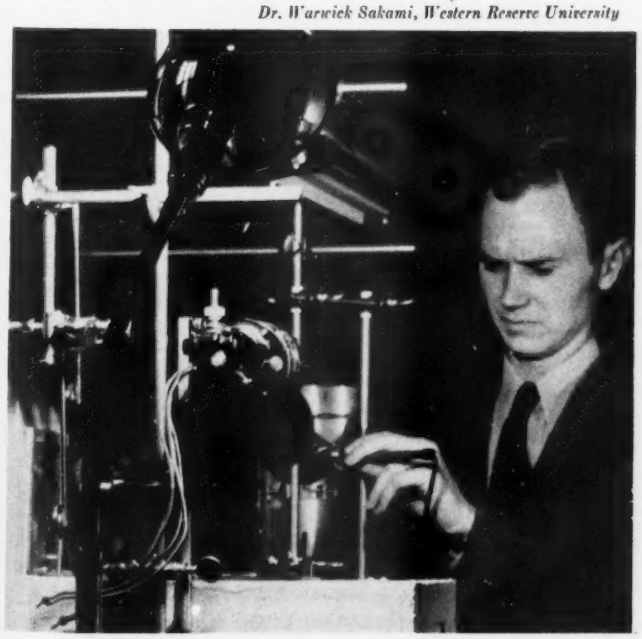
iodide (Figure 6). Each step in this reaction has a 90 to 100 per cent yield.

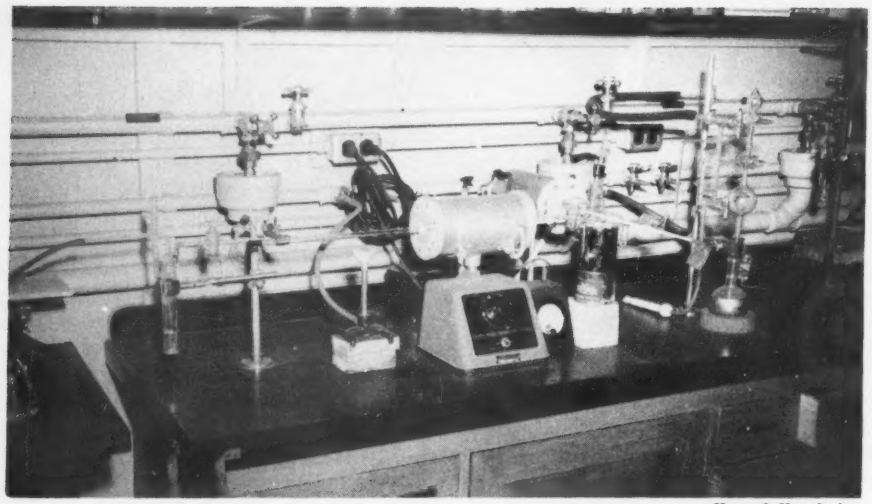
Instead of performing all of these steps in the laboratory, researchers have also allowed nature to do some of the work of synthesis. Feeding carbon dioxide tagged with carbon 11 to *bacterium coli*, one group has had this compound reduced to methyl formate in one step, going on from that point to synthesize methyl iodide and derivatives.

One of the uses of this isotopic methyl iodide is in the synthesis of radio-methionine. Methionine, a sulfur-containing amino acids, is one of the indispensable body

The assembly of a perfusion apparatus for the study of the metabolism of the isolated heart

Dr. Warwick Sakami, Western Reserve University





Kenneth Kopple, '51

Apparatus for obtaining hydrogen samples from organic compounds

building blocks. Through the use of its tagged form, researchers have been able to trace its animal metabolism (oxidation and conversion to cystine, an important constituent of animal protein) and find where this process takes place in the organism.

Other research with carbon isotopes has been done in the study of protein synthesis and use in the organism. The synthesis of peptides *in vivo* and the transmigration

Extracting a sample of CO_2. For the determination of C^{13} in an organic compound it is first burned to CO_2 with the Van Slyke wet combustion mixture. The CO_2, collected in sodium hydroxide solution, is extracted with lactic acid and collected in the labelled bulb shown in the picture. The bulb is then transferred to the mass spectrometer and the $C^{13}O_2/C^{12}O_2$ ratio determined.

Dr. Warwick Sakami, Western Reserve University

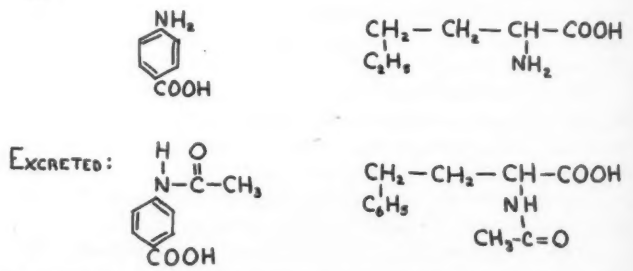
of carboxyl groups have been studied with carbon isotopes. However, in dealing with protein metabolism, isotopic nitrogen is often a greater aid.

Syntheses with Nitrogen 15

The nitrogen isotope used in biochemical work is the stable nitrogen 15, which is one unit heavier than common nitrogen and can be detected by means of the mass spectrograph. Produced by physical separation, this isotope is available in the form of ammonium salts (chloride or nitrate) and must go through several steps before it can be put into organic material for research.

The study of amino acids and protein involves the tracing of amine nitrogen. Nitrogen 15,

Figure 8. Excretion of foreign amino acids



located in the NH_2 group, is a powerful tool in such work. Ordinary methods of adding amino nitrogen to organic compounds are far too wasteful to be used with isotopic ammonia derived from isotopic ammonium salts. The usual amine synthesis requires reacting an alpha bromo acid with fifty to seventy moles of ammonia. This is obviously impossible in view of the small amounts of isotope available. Two procedures entailing less waste are in use: catalytic hydrogenation of alpha keto acids in ammonia and formation and hydrolysis of a phthalimino ester (Figure 7).

The first and simpler procedure involves hydrogenation in a fifty per cent alcohol solution over a metal catalyst. The second, used when the first does not produce the desired result, involves condensing a bromo-ester with potassium phthalimide containing isotopic nitrogen. The phthalimide is prepared by condensing one mole of isotopic ammonia with one mole of phthalic acid. The condensation product of the phthalimide and the ester is hydrolyzed with acid, producing the desired amino acid. The yield, when glycine is synthesized in this method, is over ninety per cent.

Both syntheses permit almost quantitative recovery of isotopic nitrogen not actually used in the reaction.

Uses of Deuterium

Since hydrogen is an integral part of almost every organic compound, hydrogen securely attached to these substances can be used to trace them in metabolic reactions. Deuterium, or heavy hydrogen, is the isotope used in these procedures. Although this isotope is stable and must be traced by means of the mass spectrograph, the fact that its mass is twice that of the normal form makes separation relatively easy.

(*Continued on page 80*)

Why Matter Is Elastic

By ERNST A. HAUSER, Ph.D., F.I.R.I.
and DESIREE S. le BEAU, Ph.D.

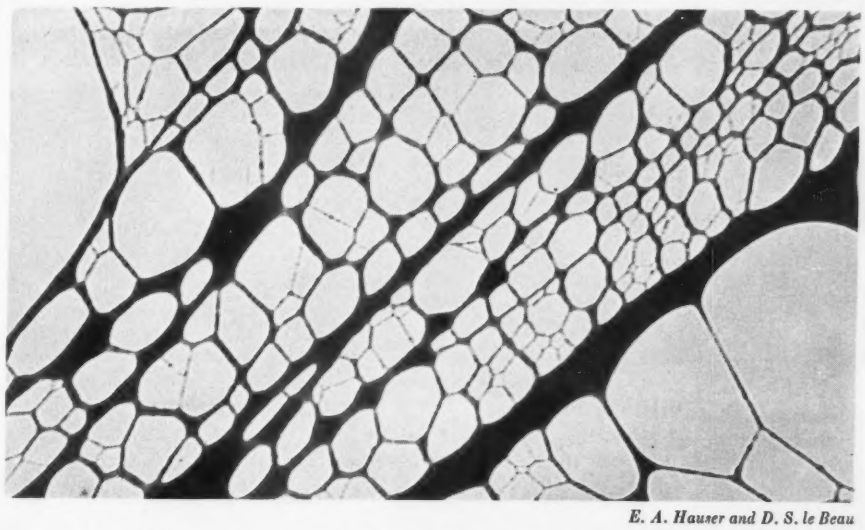
SAMUEL JOHN STONE made the following statement in an article he published in 1875: "What I can't see, I never will believe in." These words deserve far more attention in science than they have so far received. An explanation of rubber's elasticity might serve very well to prove this point of view. If you scan through the Journal of the Franklin Institute for the year 1896, you will find therein a paper by the Bostonian, Reginald Aubrey Fessenden, in which he expresses the opinion that the elasticity of rubber is due to the presence of at least two compounds, which interpenetrate but do not combine with one another. It took till 1928, however, for this hypothesis to find further support. In that year the French colloid chemist, Paul Bary, and E. A. Hauser published a paper in the *Revue Generale du Caoutchouc* on the structure of rubber. After reviewing all information then available and correlating the data obtained by straightforward chemical and X-ray diffraction analyses, they drew the following conclusions:

"1. The properties of rubber are based on the presence of two substances of identical basic chemical composition, but differing in their degree of polymerization and exhibiting very different viscosities.

"2. If total rubber is subjected to tension, the alpha part, which was dissolved in the beta part and had formed a lyogel, is separated from the latter (two-phase system). In conclusion it can be said that elongation of rubber causes separation of the dissolved substance from its solvent (theory of Hauser and Mark)."

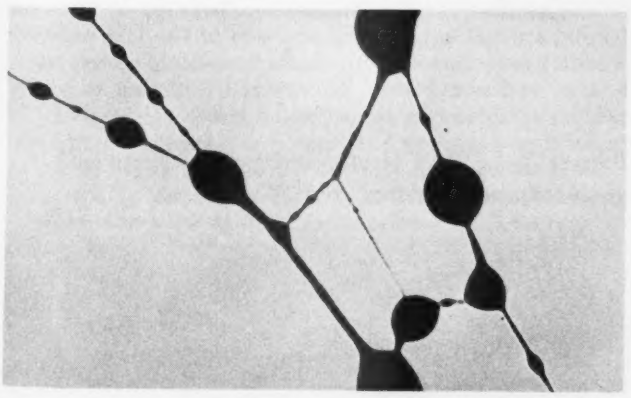
The two-phase theory did not find the attention it deserved, however, and the trend of research went more and more into the field of molecular kinetics and theories based entirely on very complex mathematics.

Elasticity was explained on the assumption that only matter composed of long chain, kinked, or snarled up molecules can exhibit this property. The undeniable fact that natural rubber is composed of isoprene present in different degrees of polymerization was either completely disregarded, or considered to be of no significance in explaining its elasticity.



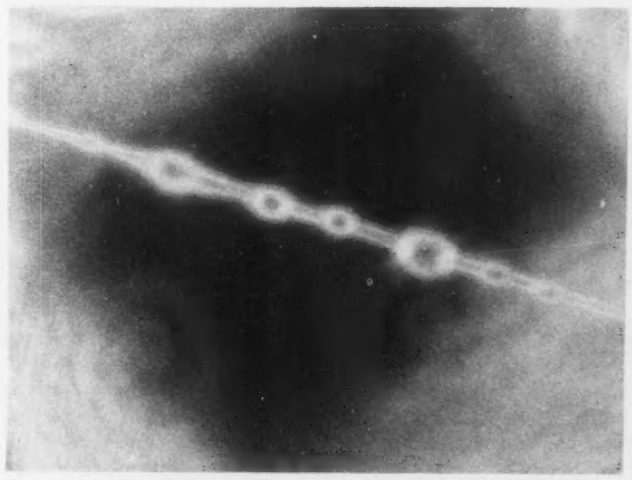
E. A. Hauser and D. S. le Beau

Figure 1. Electron microphotograph of natural rubber (total)



E. A. Hauser and D. S. le Beau

Figure 2. Electron photomicrograph of natural rubber (low molecular weight fraction)

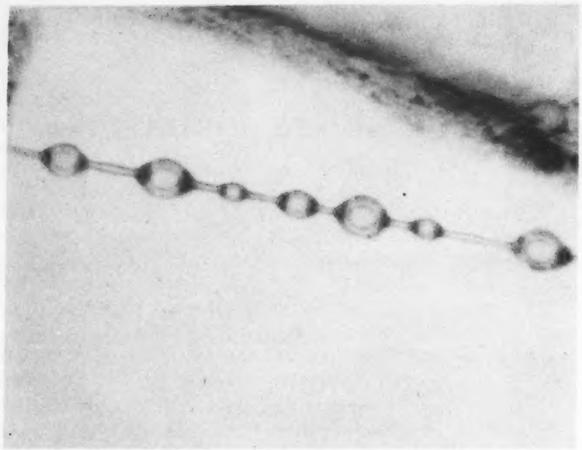


E. A. Hauser and D. S. le Beau

Figure 3. Ultra photomicrograph of natural rubber (low molecular weight fraction)

Three years ago the joint effort of the Departments of Biology and Chemical Engineering of the Institute offered the first visual proof for the two-phase theory of the structure of rubber.

In a paper written by Professors Schmitt, Hall, and



E. A. Hauser and D. S. le Beau

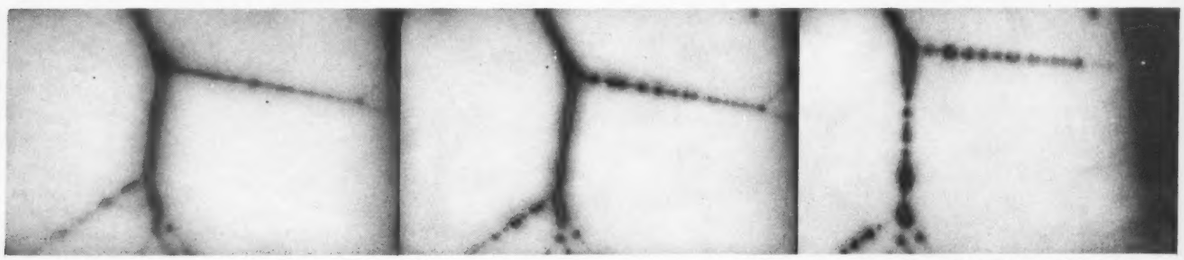
Figure 4. Positive print of color transparency of ultra photomicrograph of natural rubber (low molecular weight fraction)

varying temperatures and strains, or the effect chemicals might have on it. It therefore seemed of interest to develop a new microscopic technique which would not have these drawbacks, even if the magnifications attainable were not comparable to those the electron microscope makes possible. Taking everything into consideration, ultramicroscopy by incident light, permitting the light cone to reach the preparation independently of the focal distance of the microscope objective, seemed the best answer.

The preparations were made in the same way as those for the electron microscope. Since ultramicroscopic observations are based on the reflection of light from surfaces only, the background of the picture is dark. Nevertheless, the pictures are absolutely comparable to those obtained with the electron microscope (Figure 3), particularly if one makes a reversed print of the negative, or a positive print of a color film used in taking the picture (Figure 4).

Since the development of this technique, some observations which are very interesting and important scientifically have been made, and we shall discuss these now, before drawing our final conclusions.

If total rubber was subjected to these studies, it

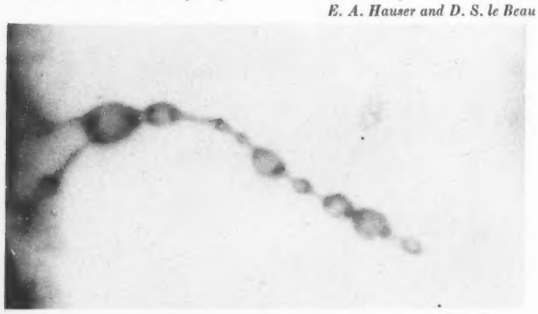


E. A. Hauser and D. S. le Beau

Figure 5 a. *0 minutes* b. *7 minutes* c. *15 minutes*
Natural rubber heated to 40°C. (reversed print)

Figure 6. Guttapercha heated to 65°C. and cooled immediately after thread broke

E. A. Hauser and D. S. le Beau



Hauser, Research Associate le Beau, and the student, Talalay, electron photomicrographs of rubber, which had been deposited from solution in an organic solvent onto a very fine wire screen, showed for the first time the existence of liquid zones which are connected by solid bands. They also were able to demonstrate that the ratio of liquid to solid zones is dependent on the molecular weight distribution of the rubber under investigation (Figures 1 and 2).

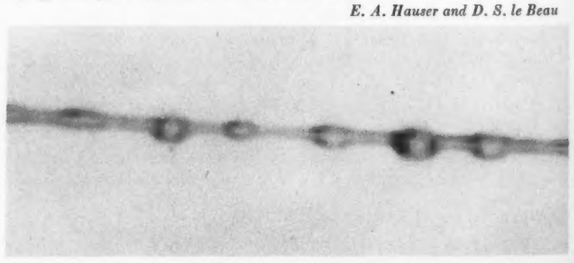
The electron microscope has, however, certain disadvantages if one is confronted with studies of typical lyogels, because their morphology is definitely affected by the high vacuum needed in the electron microscope and also by the electron bombardment to which the preparation is exposed. Besides this, the electron microscope does not permit the studying of a specimen under

was found that the appearance of the liquid zones is not an instantaneous phenomenon, but a time reaction. This becomes clear by carefully studying the changes a preparation undergoes with time (Figure 5 *a*, *b*, *c*). By raising the temperature to 40° C., this reaction is speeded up tremendously, and the maximum of liquid zone formation occurs after only fifteen minutes. If the rubber is first subjected to careful separation into a low and a high molecular weight fraction, and these are tested ultramicroscopically, one obtains the following results: The film deposited from the low molecular weight fraction collapses completely, and that containing the high molecular weights reveals only band-like filaments after the solvent has evaporated. If films for testing are made, the one composed of the low polymer is sticky and noncoherent, the high molecular one, hard, brittle, and nonelastic. However, by mixing the frac-

(*Continued on page 86*)

Figure 7. Ultra photomicrograph (reversed) of guttapercha heated to 65°C.

E. A. Hauser and D. S. le Beau

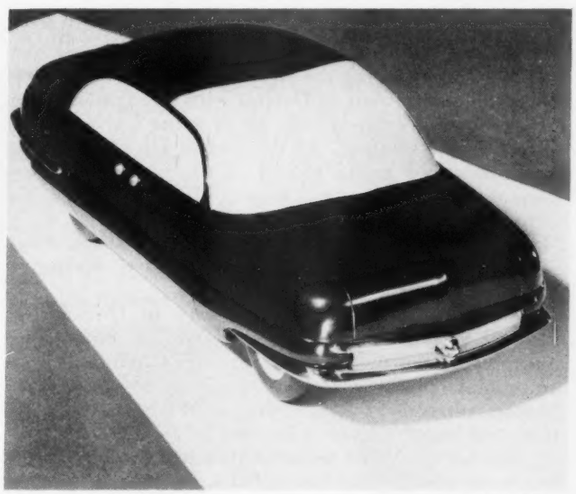


Tomorrow's Car

Prize-Winning Model Designed and Built by CHARLES JORDAN, '49

CHARLES M. JORDAN, a nineteen-year-old M. I. T. junior, is four thousand dollars richer these days and has an offer to go to work designing automobiles for General Motors when he graduates, as a result of his winning the annual model car contest sponsored by G. M.

Jordan's winning model includes many new ideas in automobile design. The engine is placed in the rear of the car and is mounted on a subchassis which can be removed in a few minutes. This feature will make it possible for the motorist of the future to drive into a garage, have his engine removed for overhauling, and have a temporary service unit installed. When the original engine is ready for use once more, it can be replaced.



General Motors

Looks almost real enough to step into! Jordan's model is set off against a white background

In the front of the car, where the engine has conventionally been placed, there is plenty of room for storing luggage and equipment. Parallel to the bumpers and protected by them are mounted the tubular headlights. These throw out a sheet of light giving a wider and more brilliant illumination of the road ahead than do those in current use.

The driver looks out through a polaroid windshield made of unbreakable plastic and mounted on a tubular frame. This windshield extends up into the roof far enough to permit the driver and front seat passengers to see the tops of high mountains and skyscrapers as they tour the country or city. An adjustable shade is mounted so that it may be pulled down as far as the driver wishes.

One of the principal objections to present automobile designs is the expense involved when one of the huge fenders is smashed and has to be replaced. Jordan avoided this difficulty by dividing the sweeping fenders and doors into two panels instead of one. With these top and bottom sections in use, replacement costs are cut in half.

An outstanding characteristic of the model is its overall simplicity. Tail lights and other exterior accessories are mounted between chrome strips encircling the front and rear fenders. The judges were impressed by the cleanness of the body lines, the lack of superfluous chrome work, and the unity of the design.

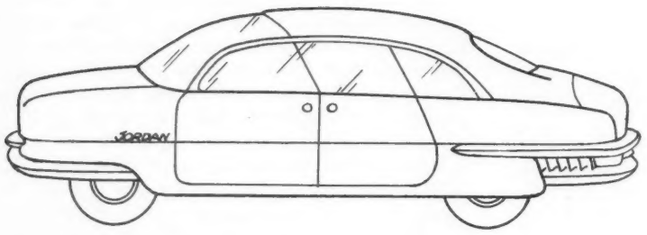
Jordan commenced working on his model in the winter of 1946, during his sophomore year. It took him a week to decide on his design and to draw satisfactory blueprints. He then made a clay model of his design.

Next came the most difficult part of the project, the construction of the model itself. In the M. I. T. Hobby Shop, Jordan began carving the model from a block of white pine; and this job lasted from January to June, 1946. All the metal parts were carefully shaped from brass, chrome-plated, and then set into the wood. In order to get a smooth surface, thirty-five coats of paint were applied to a surface previously sanded with the finest sandpaper. The finished model was 16 inches long, 5 inches high and 6¼ inches wide.

Jordan completed his model shortly before June 15, 1947, the closing date of the contest. He was first noti-

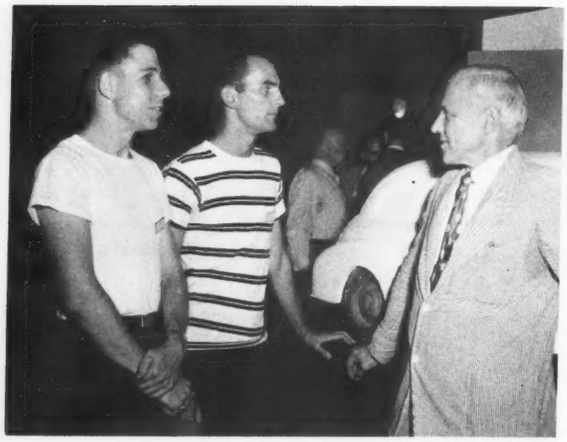
Charles M. Jordan, '49 grins approvingly at a miniature highway carrying his model in the upper background and two other prize-winning car models in the foreground.

General Motors



An ink tracing of the design for the prize-winning model

General Motors



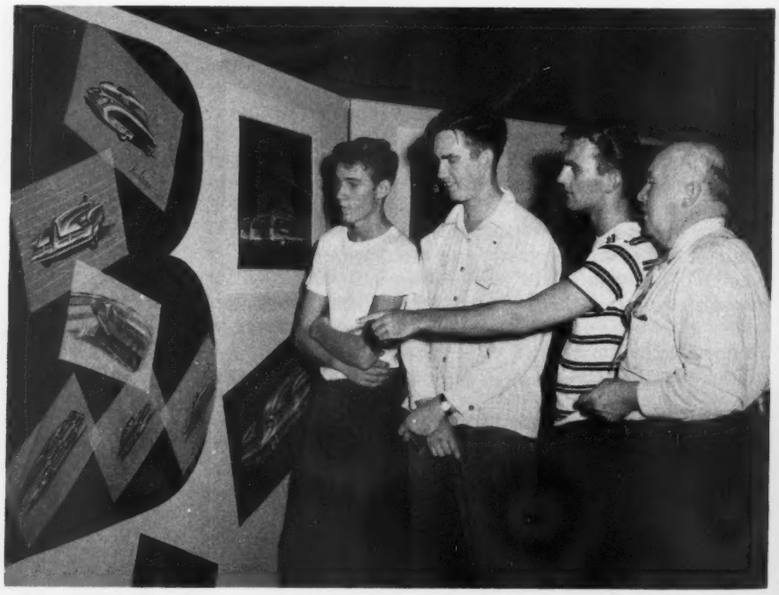
General Motors

President Compton chats with the two prize-winners from M. I. T. and seems rather pleased about their success.

fied that he had been chosen State winner, then regional winner. Representing the New England section, he was given a four-day visit to Detroit with all expenses paid. Other regional winners from all over the United States were likewise invited. At the end of his stay, Jordan was announced grand winner of the contest and was presented with his prize. Among those present at the time were Karl Compton, President of M. I. T.; R. A. Millikan, President of Cal Tech; C. E. Wilson, President of General Motors; and Charles Kettering, Research Director of General Motors.

While the regional winners were in Detroit, the General Motors Corporation took them on a tour of the motor capital of the world. The tour included the large automobile plants and such sidelights as the General Motors proving ground, General Motors styling section, and many points of interest in Detroit.

Besides the model he entered in this contest, Jordan has made many other models of a similar nature in his spare time. He first started carving them as a youngster in grade school. In addition, he has done many water color drawings of modernized cars and trucks, which he has hung about his room.



Charley Jordan points out a favorite design in one of the General Motors' styling salon exhibits. On the wall, you might see the car of 1955 in its first form.

General Motors

Radio Hams' Get-Together

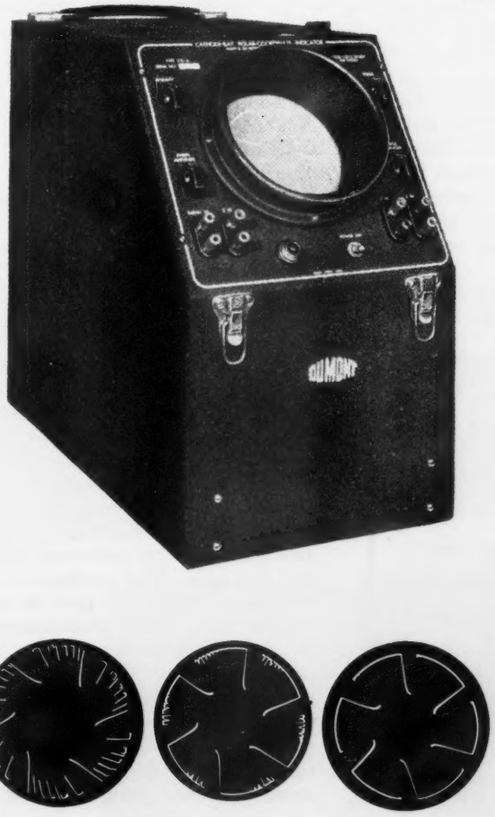
By RALPH C. JOHNSTON, '50

ON Saturday, October 18, the fifty-year-old walls of Mechanics Hall, Boston, were filled with people, talk, and equipment that seemed somewhat out of place amid the building's nineteenth century gingerbread trim. The people were Hams, amateur radio operators; the talk was of subjects such as xtalectors, wire recorders, six-meter converters, television, and ultra-high frequencies; the equipment was the newest and best in amateur radio devices. The reason for the coming together of all these people was the Tenth Annual Boston Hamfest, the New England Division of the American Radio Relay League Convention, which was sponsored by the Eastern Massachusetts Amateur Radio Association and the South Shore Radio Club.

As the name suggests, hamfests are get-togethers of radio amateurs. Like most Americans, hams have a love of conventions, and the hamfests allow them to gather to hear about new developments, see the latest equipment, meet the people with whom they had been talking on the air, and generally have a good time. Hamfests are nothing new in the United States; they are held at regular intervals in all sections of the country. The first hamfests in this vicinity were held in Quincy, Massachusetts, in 1932 and 1933 by the South Shore Amateur Radio Club. In 1934, the S. S. A. R. C. joined with the Eastern Massachusetts Amateur Radio Association in presenting the first Boston Hamfest at the Hotel Bradford. The gatherings continued to be held annually at the Bradford, with the Eighth Annual Boston Hamfest being held in 1941. The war prevented any further conventions until 1946, when the hamfests were reinstated.

The Tenth Annual Boston Hamfest was probably the largest ever held in the world. Almost four thousand people attended the event, and there were representatives from all over the United States, from foreign countries, and many from Canada. The radio clubs which sponsored the Hamfest are particularly proud of the fact that the affair was operated on a strict business basis. About two hundred and fifty door prizes of values ranging from five hundred to five dollars were given away. These prizes were paid for entirely by proceeds from the sale of display rights at the convention and of advertising in the Hamfest program, instead of being solicited from manufacturers.

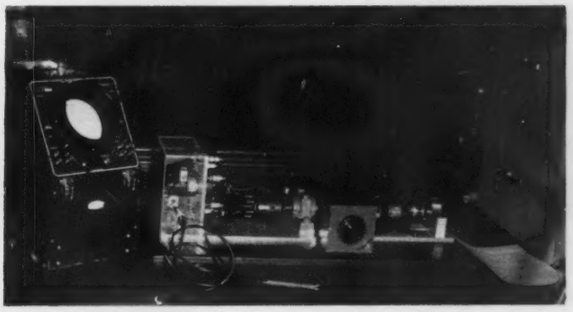
Figure 1. The Du Mont cathode-ray polar co-ordinate indicator *Du Mont*



Dan Sully, '51

Part of the official United States Navy exhibit at the Hamfest

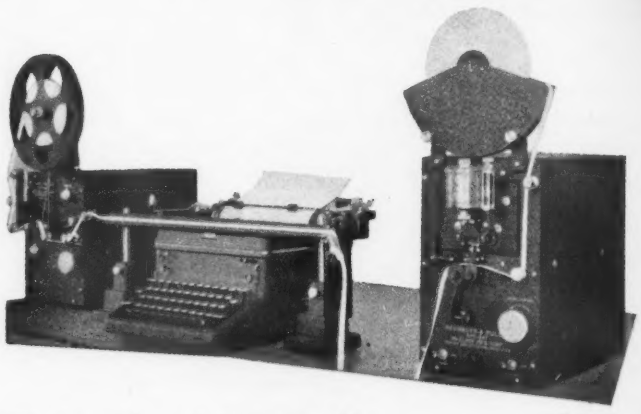
A view of the setup used to display the new Du Mont indicator *William T. Price, '50*



The main point of the convention was, of course, the lectures and commercial displays presented. The program, which started at 9.00 a.m., included F. C. C. license exams, code contests, A. R. R. L. meetings, movies, technical lectures on A. R. R. L. regulations, the use of radio in espionage, wire recording, ultra-high frequencies, and lectures by military representatives on Army and Navy amateur radio programs. Eleven companies set up booths in the Grand Hall displaying the newest products available to amateurs and distributing volumes of technical literature to the conventioners. The United States Naval Reserve exhibited a mobile air station communications unit, and the United States Army Signal Corps's display included several walkie-talkies over which intrigued amateurs conversed all day. From 11.00 a.m. to 6.00 p.m. the Continental Television Corporation exhibited televised movies, and at 8.00 p.m. it had a "live talent" television show. Ham radio stations K1USN/1 and W1IAE operated from the Grand Hall from 11.00 a.m. until 7.00 p.m.

Of the many lectures given, the ones most encouraging to amateurs were probably those given by the Army and Navy representatives. The Army lecturer, Lieutenant-Colonel Simmons, of the Signal Corps, revealed that the Government now has under consideration legislation that will permit the sale of surplus military radio equipment at low prices to civilians. At the beginning of the last war the civilian hams donated almost all of their equipment to the armed forces, and it has been suggested that the military should help the civilians back on the air. The pending legislation would sell surplus radio equipment to civilians in much the same manner as surplus rifles have been sold. The Colonel also revealed that the Army is now setting up an amateur radio network called the Military Amateur Radio System. The function of the network will be to provide a civilian group which will complement existing Army communications units. As planned, the system will be in operation by January, 1948. Membership in the new group is restricted to licensed amateurs. Men in the Army, Air Force, National Guard, and Reserve Officers' Corps may join and use Army equipment. The only civilians who may join the system are those who are already on the air. The Army cannot furnish equipment to any civilians until the above-mentioned legislation is passed. The system for the First Army Area, which includes New England, New York, and New Jersey, will operate on two frequencies, one just outside the 40-meter band and the other just outside the 80-meter band. The First Army Area control center will be W2USA, located on Governor's Island, New York, and there will be an alternate control center W1USA in Boston. The network will have frequent drill practices on the ham bands.

The Naval Reserve representative, Commander R. E. Coleman, told of the Navy program that is the equivalent of the Army system. The operations of the Naval network will be quite similar to those of the Army, and, as in the latter, membership is at present restricted to members of Reserve groups and to civilian amateurs already on the air.



High-speed receiving assembly McElroy

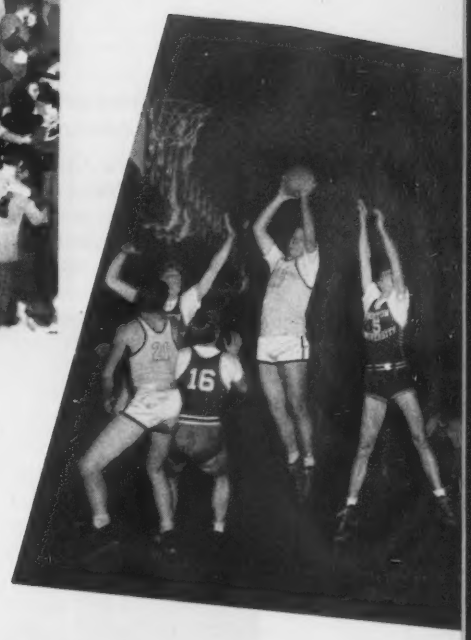
Of the commercial displays at the Hamfest, several were outstanding for the spectator interest they drew. The most popular of the exhibits was the television show put on by the Continental Television Corporation Throughout the day the group showed telecast movies of famous sports and news events on two television sets of screen widths of ten and fifteen inches.

The Robert A. Waters exhibit featured a new device that should be of interest to all engineers, the Du Mont Polar Coördinate Cathode Ray Indicator. As the name suggests, the device is a cathode ray oscillograph that plots varying functions on its screen in polar coördinates instead of the more commonly used rectangular coördinates. In the past, oscillographs have been largely designed with an eye toward solving the problems of electrical engineers, and mechanical engineers have had to rely on mechanical means for the investigation of such problems as peak transient pressures in fuel injection systems, angular acceleration and torsional stresses in crankshafts, and the effect of vibration and resonance on various mechanical linkages. The mechanical instruments used in the past for such studies have been unsatisfactory because of their large mass and correspondingly poor high-frequency response. Since most problems of which the above are typical must be evaluated with respect to the angular position of some reference point, a polar co-

(*Continued on page 98*)

Some of the browsers at the Hamfest spent most of their time looking wistfully at the equipment that they would like to own

Dan Sully, '51



techsapoppin!

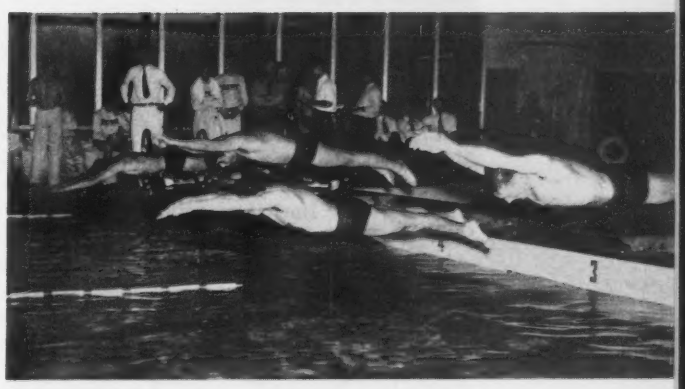
Techsapoppin week-end, December 5 and 6, was a big success despite a premature snowstorm.

The show was put on the road by a Boston University–Tech basketball game at Mechanics Hall. In spite of an early and persistent lead, the Engineers were the losers by the narrow margin of 51 to 49. Hal Reeves and his soothing music took over for the remainder of the evening and thirty beautiful young ladies were picked from among the dancers to be the finalists in the beauty contest held on Saturday night.

Saturday afternoon the feature attractions were open house, a Dormitory tea, fencing exhibition, swimming meet, wrestling matches, and a squash meet. Tech was the victor over Wesleyan at squash, while the swimming team was dunked by Brown, and the wrestlers were floored, also by Brown.

Judges at the beauty contest on Saturday night were Dr. Compton, John Powers, and Dahl of the *Boston Herald*; their final choice for Queen was Dorothy A. Williams, a Wellesley College senior.

A torchlight procession brought the spectators to the Boston Arena where an outclassed Tech team was defeated by Boston University 10 to 5 in a fast and furious hockey game.



HOW MANY UNIVERSES?

By PETER B. NEIMAN, '49

"A broad and ample road whose dust is gold
And pavement stars."

SUCH were the words Milton used to describe the delicate band of misty light completely surrounding the Earth, known in all languages as the Milky Way. Before the advent of the telescope, it was thought to be a mysterious celestial halo, made of flowing matter,

W. H. Steavenson, Pretoria

The brightest and widest part of the Milky Way, from Antinous to Scorpio

and not of star stuff. But when Galileo observed it through his first crude telescope, he found that this flowing halo had resolved itself into countless myriads of stars. He had thus solved the mystery of a "milky way," and had unwittingly created a new one: How does it happen that in one small band of the celestial sphere there is an almost inconceivable density of stars, many more than in all other regions? And as an afterthought, where does the Earth and man fit into this curious plan?

As men began to explore the Milky Way, they came upon a rather curious fact. Certain open groups of stars, comparable to a swarm of bees, were increasingly evident as telescopes were pointed along the plane of

The great Nebula M31 in Andromeda, which is the most conspicuous of the star-cities in space. The light from the nebula takes 900,000 years to reach the Earth, and it is so vast that light takes nearly 50,000 years to cross from one side to the other. *Yerkes Observatory*

Milky Way, stars were sparsely situated, but along the line of sight of the Milky Way, stars (and as later determined with improved instruments, Globular Clusters) were far more numerous, since one was then sighting along a "spoke" of this celestial cartwheel, and consequently saw all the stars along the spoke, as well as those along the rim.

This cartwheel universe is essentially the same as Shapley's biscuit universe, with one exception: our Solar System is not at its center. Instead, latest measurements have shown that it is at least fifty thousand light years away from the center. It is interesting to note that once again the tacit assumption that man is at the center of things has been disproved by scientific observation!

The measurements Shapley made on Globular dis-

(*Continued on page 90*)

the Milky Way. These so-called Globular Clusters had been observed before, but their appearance was rare, and their distribution was random. In the region of the Milky Way, however, they appeared quite often, and their distribution was almost uniform in a certain shape of space. Harlow Shapley made a study of Globular Clusters and came to the conclusion that the farthest ones were about ten times as far as the nearest ones, or at about one hundred and eighty-five thousand light years, where a light year is the amount of space light covers in a year, traveling at one hundred and eighty-six thousand miles a second. He also concluded that the shape of space in which these clusters were at maximum uniform density was that of a flat, biscuit shaped disk, with the band of the Milky Way as its periphery.

About one hundred and thirty years ago, Sir William Herschel reached a similar conclusion. From a study of the apparent distribution of stars, he concluded that the universe itself must be like a cartwheel, with the Solar System as the hub. In regions normal to the

The lesser Magellanic Cloud *Arequipa Observatory*

Push Button Steel Mill

By MYLES SPECTOR, '50
and RALPH C. JOHNSTON, '50

LOCATED in the city of Homestead, Pennsylvania, just outside Pittsburgh, is one of the nation's largest and most modern steel mills, the Homestead plant of the Carnegie-Illinois Steel Corporation. The Homestead plant, although located in the primary steel producing district of America, stands out among other steel mills for its size, efficiency, and design innovations. The works, covering an area of about six and one-quarter square miles and employing some 13,500 people, performs all the operations necessary to turn raw iron ore into finished sheet and plate steel.

For purposes of description, the plant may be broken down into three more or less distinct operational parts. The first part is composed of the blast furnaces and open-hearth furnaces which turn iron ore into steel ingots. The second part takes the ingots and produces steel slabs. The third operational part of the mill transforms the steel slabs into flat steel sheets and plates.

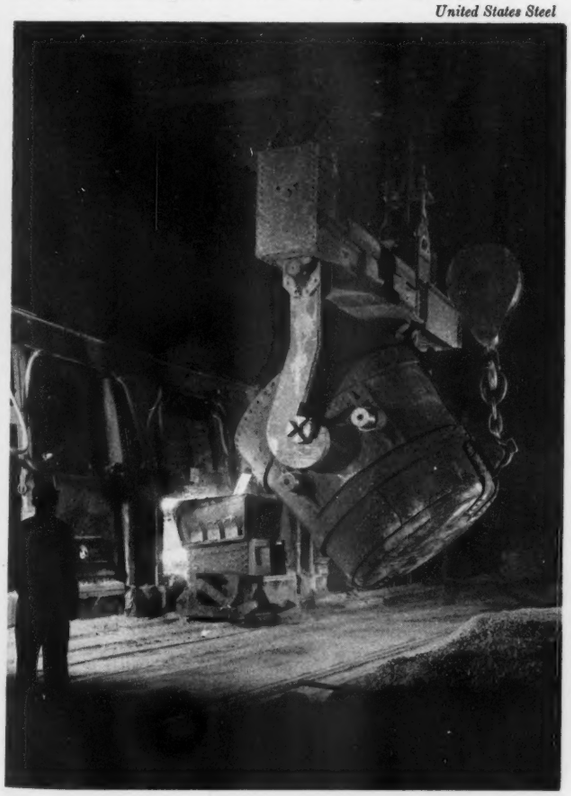
Before going any further, it would probably be best to define the terms used to refer to the various forms the steel takes on its way through the mill. An ingot is a block of steel with dimensions of approximately 29 inches by 66 inches by 96 inches and with a weight of about 40,000 pounds. A slab of steel is a block at least 1½ inches thick with a width of much more than twice its thickness and an indefinite length. Slabs usually have a cross-sectional area of not less than 16 square inches. The terms plate and sheet are often used indiscriminately, but, by American Iron and Steel Institute standards, plates are pieces of steel with a width to thickness ratio of about 80 to 400 and sheets are steel pieces with width to thickness ratio of between 1/500 and 1/1000.

United States Steel

A sample of steel is removed from the open hearth furnace for testing in a production control laboratory

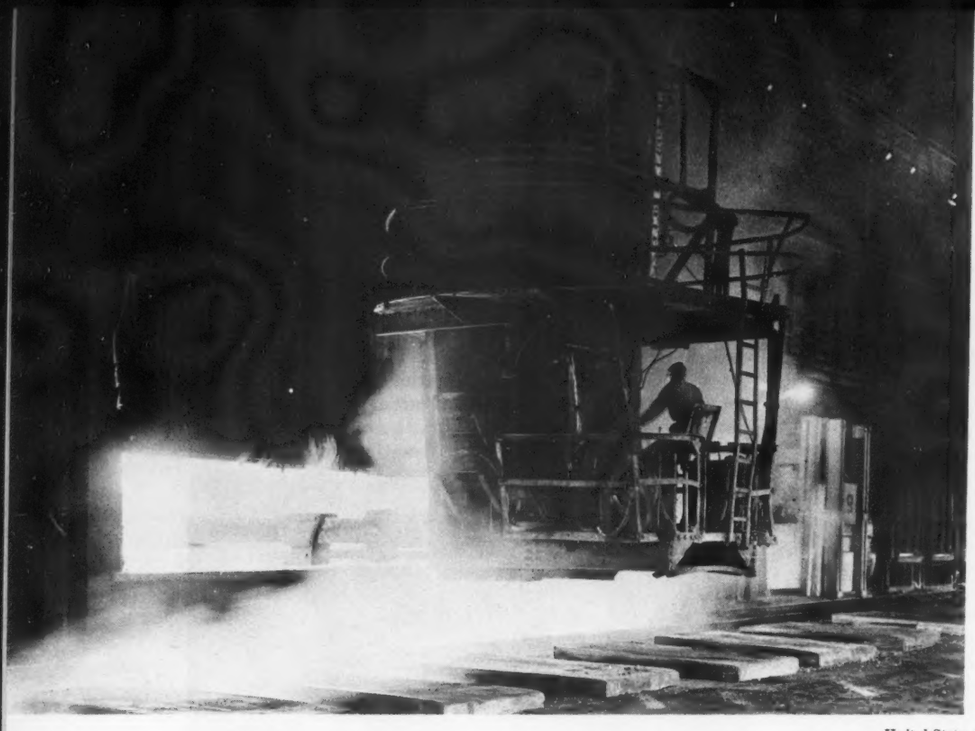
A gigantic ladle tilts, and molten iron from the blast furnace pours into the open hearth

United States Steel



Returning to the Homestead plant, let us first consider the first operational group mentioned above, the blast furnaces and open hearth furnaces. Into the blast furnaces is introduced a mixture of iron ore, coke, and limestone. The contents of the furnace are heated to the combustion temperature of the coke, and air is blown through the furnace. The partial combustion of the coke produces carbon monoxide gas which in turn reduces the iron ore to molten iron and in doing so is oxidized to carbon dioxide. The limestone unites with impurities present to form a relatively light slag. The slag floats on top of the iron and is tapped off. The molten iron is tapped from the bottom of the furnace. The operation of a blast furnace is continuous, with the raw materials being charged into the top of the furnace and the molten products being tapped off without the furnace ever being shut down. The furnaces usually need to be shut down for repairs only once in five to seven years.

The molten iron from the blast furnaces is carried in large ladles to the open hearth furnaces. The open hearth furnaces are large brick-lined and enclosed vats. There are eleven furnaces at Homestead, each with a capacity of from 225 to 250 tons of steel. Ten of the furnaces are usually kept in operation with the eleventh closed for repairs. In the open hearth furnace an



United States Steel

The slab reheating furnaces at the Homestead Works

intense gas flame burns over the surface of the metal and carries off the impurities in it. Then steel scrap and the various alloying constituents necessary to steel are added to the molten metal to make the iron into steel. The apparently wasteful process of eliminating the impurities and then adding them in the desired amounts is actually more efficient than trying to reduce the impurities to the desired level. The molten steel from the open hearth furnaces is then cast into ingots. The above processes are largely standard in all steel mills using the open hearth type of furnace.

From the open hearths, the ingots travel to the Homestead universal slabbing mill, the second operational part of the mill. The still hot ingots are transferred from the furnaces to the slabbing mill on railroad cars. At the slabbing mill they are placed in soaking pits by large overhead cranes. A soaking pit is a furnace in which ingots are stored at about 1800° F. During their stay in the soaking pits the ingots become uniform in temperature and composition. At Homestead there are twenty soaking pits, each capable of holding from four to six ingots. Access to the pits is obtained by removing a cover over them by means of moveable cranes which span the pits.

After being heated for a predetermined time, the ingots are taken from the pits to the slab mill. The ingots make the trip in an ingot buggy which is an electrically driven railroad car equipped with a tiltable cradle behind a roller platform. An ingot is placed in the cradle by an overhead crane and the remotely controlled buggy takes it to the first rolling mill. The maximum travel of the buggy from the farthest soaking pit to the rolling mill is 450 feet, and the buggy makes the trip in 50 seconds, attaining a maximum speed of almost 80 miles per hour. When the buggy reaches the rolling mill, the cradle tilts forward and the ingot falls on the roller table of the buggy. The rollers are powered and move the ingot onto the ingot receiving table. Here the ingot is weighed and turned around. The procedure of turning the ingot is one of the unique features of the Homestead plant. If the ingot were run through the rolls as the ingot buggy delivers it (as is done in most steel mills) the piped end of the ingot would go first. The piped end of the ingot is that which contains a deep depression due to the shrinking of the molten metal while it solidifies after being cast. The piped end is naturally the weaker end of the ingot. After the ingot is reduced to slab size, it is sheared to a desired length. If the piped end of the slab came to the shears first, just a small portion of the piped metal would be sheared off so that the amount of slab remaining would be sufficient to meet the length requirements of the finished slab. If the piped end of the slab reaches the shears last, only enough metal is cut from the front end of the slab to square that end. Thus, a maximum amount of excess metal is removed from the piped end of the slab. When the ingot has been weighed and turned it is sent through the rolling mill. The mill consists of two horizontal rollers, 45 inches in diameter and 80 inches long, each powered by one 5,000 horsepower electric motor, and two vertical rolls, 36 inches in diameter and 80 inches long, both powered by one 3,000 horsepower motor. Having both vertical and horizontal rolls allows a rectangular cross section to be maintained in the slab. The ingot is reduced to the desired cross section by repeated trips back and forth through the rolls. One feature of the

A smooth, hard finish is given to steel sheets in a temper mill

United States Steel

rolling mill at Homestead is that the rolls and their motors can be completely reversed in direction of rotation in just three seconds. A much discussed innovation in rolling mill design was incorporated in the Homestead plant when roller bearings were used on the horizontal rollers instead of the more common babbit bearings. The operation of the mill has shown the roller bearings to be more economical in operation and maintenance than the old bearings, and future rolling mill designs will probably incorporate this feature. The entire handling of the ingots from the soaking pits through the main rolling mill is controlled electrically from a glass enclosed booth, called the pulpit, located on the delivery side of the main rolling mill. Only two men occupy the pulpit and they have complete control over the processes which the ingots undergo.

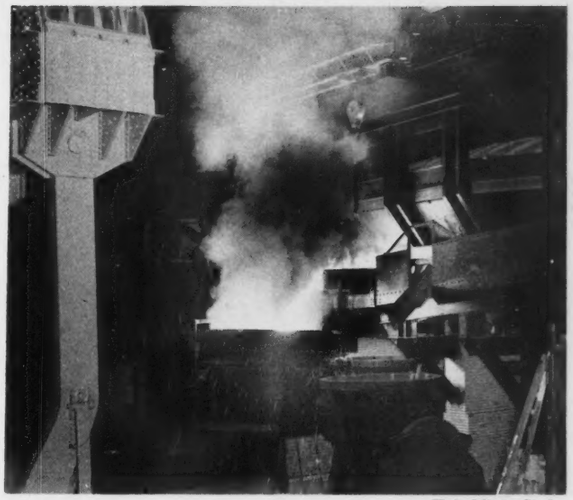
From the main rolling mill the slabs pass over a powered roller conveyor to the scale disposal machine.

Pouring the molten steel into the ingot forms

United States Steel

The scale of oxidized metal which formed on the slab during rolling is knocked off at this point and is carried away by a water flume under the conveyor. Next the slab goes through the scarfer, a machine which removes thin layers of steel from the vertical edges of the slab by means of oxy-acetylene cutting torches. The slabs are then cut to the desired length by a large hydraulic shear. The shear and the scarfer are both remotely controlled from a second pulpit similar to the one near the main rolling mill. The now finished slabs are carried by electric cars to the slab storage yard where they are cooled by air or water, depending upon the type of steel desired. From the storage yard the slabs are either sold to customers or sent to the sheet and plate mill.

The sheet and plate mill is the third operational unit mentioned at the beginning of the article. The function of the sheet and plate mill is to further reduce the cross-sec-



United States Steel

Molten steel showers sparks as an open hearth is tapped

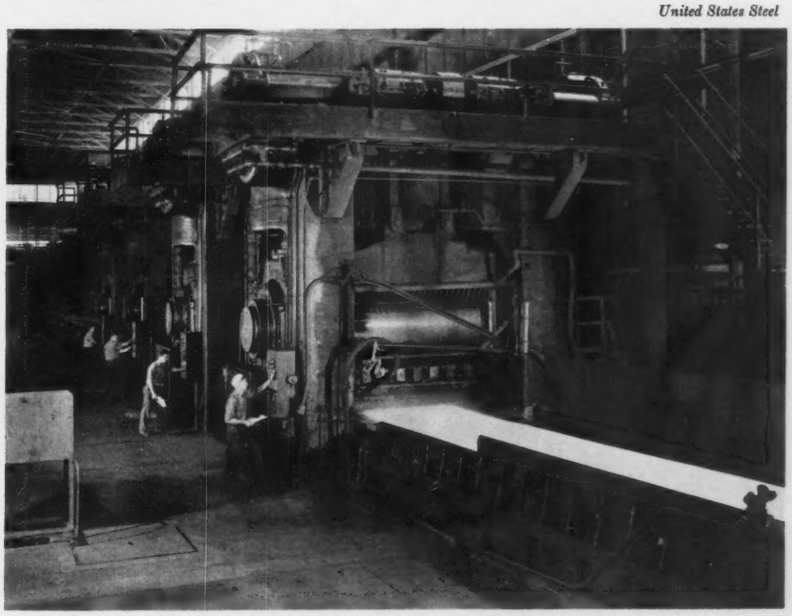
tion of the slabs to more useful dimensions. The slabs are heated in slab furnaces prior to rolling to raise them to hot-working temperatures. The rolling mills of the sheet and plate mill perform much the same operations as those of the slab mill. The main difference between the slab and sheet mills is that the cross-sectional area of the sheets is reduced in gradual steps in a series of mills instead of by one mill, and finishing operations take place between the different rolling stages. In the Homestead 100-inch plate mill the slabs go through eight reduction and finishing operations in succession. The plate is then leveled and allowed to cool. The only operations necessary to finish the sheet are shearing to size and packaging.

The Homestead plate mill can produce sheets and plates up to 100 inches wide, the only mill of such size in the country. The slab mill can produce slabs up

(*Continued on page 88*)

Four of the rolling mills that compress hot slabs to thin plates

United States Steel



The Irvin Works of the Carnegie-Illinois Steel Corporation at Vandergrift, Pennsylvania
United States Steel

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Can You Do It?

THE TWELFTH IN A SERIES OF MONTHLY BRAINBUSTERS

THIS MONTH: Two ancient problems . . .

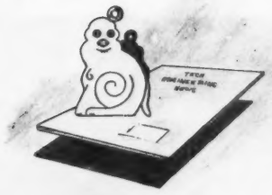
Problem 1: It was a hotly fought battle. At least 65 per cent of the participants lost a leg, at least 70 per cent lost an arm, at least 85 per cent lost an eye, and at least 90 per cent lost an ear. How many lost all four members?

Problem 2: A certain ancient, Arab lover of slow living provided in his will that his entire estate should be inherited by one of his sons. Having three such sons, he further provided that the lucky son should be determined by having the sons run a camel race, the one whose camel crossed the finish line *last* to be the winner. Of course, the three sons mounted their camels but refused to budge from the starting point, each being unwilling to cross the line first. A passing wise man perceived the situation and, calling the three sons together, whispered something into their ears. Immediately the three sons remounted and dashed across the finish line as rapidly as possible. What did the wise man say?

J. W. W.

(Answers next month. Answers to last month's problems are on page 98)

The Dragon's Den



Equation for Righteousness . . .

On Saturday, December 6, 1947, the *Boston Herald* editorially advised the president of Simmons College to either fire Dr. H. L. Harley, psychology professor at that institution, or make sure that any and all connection that he might have with the Communists be severed. Dr. Harley is director of the Samuel Adams School, one of the organizations designated by Attorney General Tom Clark as under Communist influence. The *Herald's* diatribe on the subject was well mixed with assorted opinions on "liberalism," controversial textbooks, and educational responsibility. Also mentioned somewhere was the defensibility of "academic freedom."

There is *no* mention of Dr. Harley's own political views, *no* word whatsoever on what the Sam Adams School teaches, and *no* explanation of how Marxist theories change the facts taught in psychology or physics or math classes. There is a flat acceptance of a dictum issued by the Attorney General. But we should not fall into the error of thinking that the premises were correct even though the method was shaky and illogical. To quote: " . . . identification of Communism with the imperialistic nationalism of Soviet Russia . . . [no] honest doubt that a bona fide Communist is an agent of a foreign power. . . ." These statements are certainly open to argument. In New York, for instance, there is a large faction of Communists who are openly anti-Stalin, and thus, anti-Russian, for all practical purposes. Under the rather "radical" theory that people with knowledge, no matter what their political connection, are entitled to teach students interested in that knowledge, we would advise that the *Boston Herald* mind its own business and stop interfering with the *rights* of free speech.

Within the past two weeks, two colleges have barred speakers who were "suspect" in their loyalty. Columbia University refused permission to the PCA chapter to have Howard Fast speak, because "of the practice of not permitting anyone under sentence to speak. . . ." (Mr. Fast is being held in contempt by the Un-American Activities Committee and is awaiting sentence) C.C.N.Y., though, which forbade the appearance of Arnold Johnson, legislative director of the Communist Party, before the Marxist Cultural Society, gave a reason which seems to strike a bit closer to the truth. "We must refuse the use of college facilities to individuals or groups recognized as subversive to the city, state, or nation." Since it would be hard to show the weakness in the statement itself, examine for a moment its premises. They make it impossible to present to students (people who are supposed to absorb knowledge) a philosophy which differs radically from that decided on in Washington. This subverts the purpose of education in a manner similar to the way Germany emasculated hers and akin to the method probably used by Russia.

One might think that these are isolated instances of the civil authority's effect on academic dissemination of knowledge. They are not. Closer to home, at Harvard, the HYD, Harvard Youth for Democracy, is currently engaged in a running battle with the dean's office for permission to sell on campus the publication, *The New Student*, which they edited. This magazine has already been approved and sold on many other college campuses. The dean is probably worried about civil authority's opinion: is the magazine a campus representative for outside influences? The editorial board has made it reasonably clear that outside articles are solicited and not sent, and thus the delay in approval must be due to some fears or the dean's personal opinions.

Inevitably, the assumption of choice by civil rather than academic authority, will lead to a deterioration in the quality of learning. Students in Soviet Russia and the former students of Nazi Germany could not have been as well versed in social sciences as equal students in this country. And, if the same mismanagement which marks much government control enters into the educational field, then certainly the scientists and engineers will also face the black uncertainties of an unstable future.

E. M. K.

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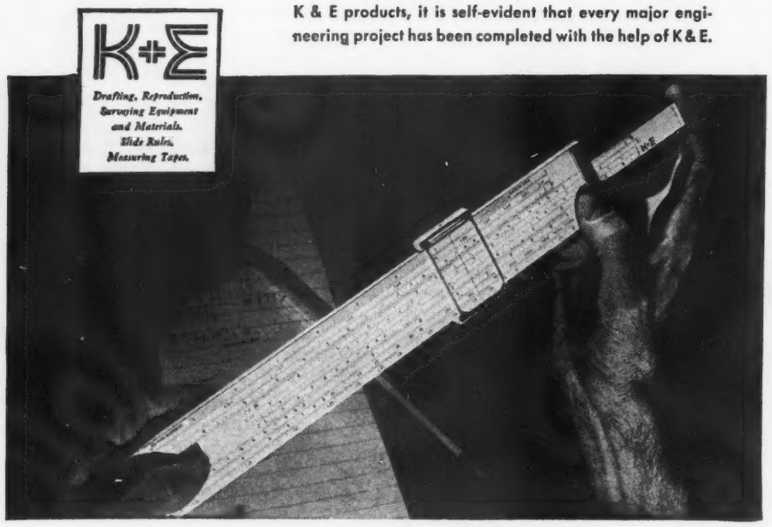

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TAGGED MOLECULES

(*Continued from page 64*)

Isolated from natural hydrogen gas, in which it is present in small quantities, deuterium is available in the form of heavy water, D_2O, or deuterium gas. Introducing it into an organic molecule can be done only in a relatively few ways. The two most important are substitution or exchange of deuterium for normal hydrogen and addition of deuterium to unsaturated compounds.

Deuterium has been used as a tracer atom in many biochemical researches. Two interesting examples follow. When various amino acids, foreign and useless to the body, are administered to animals, they are excreted as their N-acetyl derivatives (Figure 8). In order to find the source of this acetyl fragment one group administered to test animals the deuterio-acetyl derivatives of natural amino acids in combination with amines which were not assimilated by the organism. By tracing the tagged acetyl groups through excretion, it was found that they had become attached to the nitrogen of the foreign amines administered, although they had originally been linked with the nitrogen on the natural amino acids. Aside from this, it was found that the type of foreign amine fed made a great deal of difference in the amount of tagged acetyl excreted in combination with the foreign amine. When para aminobenzoic acid was administered, the amount of acetyl excreted in combination with it was only one-fifth that found when alpha-amino, gamma-phenyl butyric acid was administered.

This, plus other data gathered with the aid of the tagged groups, tends to indicate that a direct transfer of acetyl takes place in the acetylation of alpha amino acids in place of the expected hydrolysis to acetic acid. With the para aminobenzoic acid, which is not an alpha-amino acid, the amount of excreted N-acetyl compound might be explained by hydrolysis and subsequent acetylation.

Whether or not the substances which go into the organism of a mammalian embryo are produced by the maternal host has long been a matter of controversy. To help clarify this question, work has been done in tracing, by means of heavy hydrogen, key organic materials which make up the embryo. Pregnant rats were chosen for this study because the structure of the placental wall which encloses the fetus is not unlike that in the human race.

Aside from heavy water, two other deuterium containing substances were prepared — deutero-cholesterol and a mixture of deutero-fatty acids. The former was prepared by a platinum-catalyzed exchange reaction between cholesterol and heavy water. The fatty acids were made by treating the long chain unsaturated acids from linseed oil with deuterium over a catalyst (Figure 9).

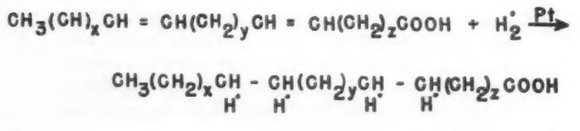


Figure 9. Hydrogenation of unsaturated fatty acids with deuterium

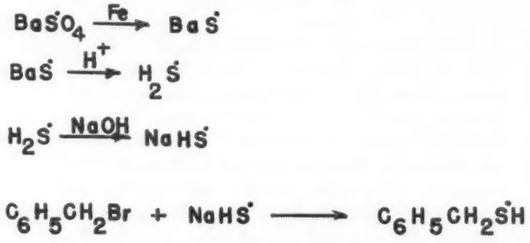


Figure 10. The synthesis of benzyl mercaptan containing radiosulfur

The diet of the pregnant rats was first enriched with heavy water. Any compounds synthesized by the fetus would therefore contain heavy hydrogen, since no other source of heavy hydrogen existed. Deutero fatty acids were fed to other animals and deutero cholesterol to a third group. Any compounds related to these which were found in the fetus must have come through the placental wall.

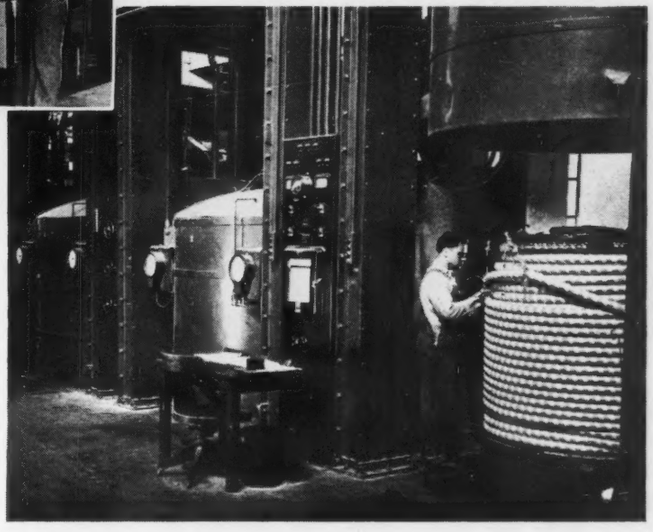
(*Continued on page 84*)

NUMBER 8 OF A SERIES

Newsworthy Notes for Engineers

Speedway for new telephones

Here you see the "wind-up" of nearly two miles of overhead conveyor lines designed by Western Electric engineers for their vast new telephone-making shop in Chicago. As finished telephone sets near the end of the assembly and inspection line, an electronic selector unerringly sorts out six different types, directs each type down the right one of the six different chutes for packing and shipping. Not one second is wasted. This conveyor system is capable of handling 20,000 telephones per day.



Faster way to dry cable

Before getting its protective lead sheath, telephone cable must have every bit of moisture removed from pulp insulation and paper covering. To gain greater efficiency than the horizontal steam drying method, which used to take 24 hours, Western Electric engineers designed a battery of cylindrical vacuum ovens which are lowered over reels of cable. Electric current is then passed directly through the wires of the cable, heating it to 270°F. As much as 6 gallons of water is driven out of the insulation in just an hour and a half!

Engineering problems *are many and varied at Western Electric, where manufacturing telephone and radio apparatus for the Bell System is the primary job. Engineers of many kinds—electrical, mechanical, industrial, chemical, metallurgical—are constantly working to devise and improve machines and processes for mass production of highest quality communications equipment.*

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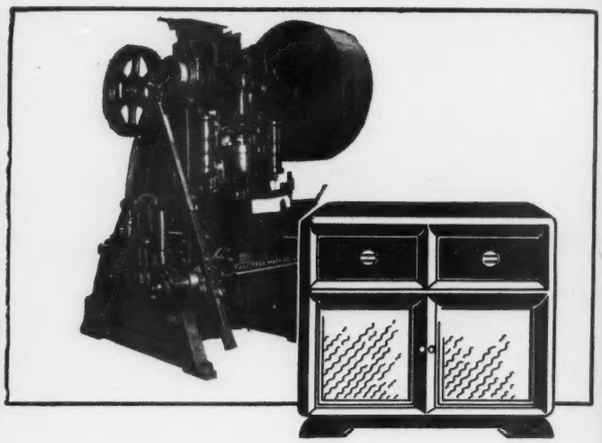

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TAGGED MOLECULES

(Continued from page 80)

The results of these tests showed that deutero fatty acids and cholesterol, when administered in the latter part of pregnancy, cross the rat placenta. When the body fluids of the rats were enriched with heavy water, deuterium was incorporated into the cholesterol, fatty acids and glycogen in the embryo, indicating that these compounds are also synthesized in the embryo itself.

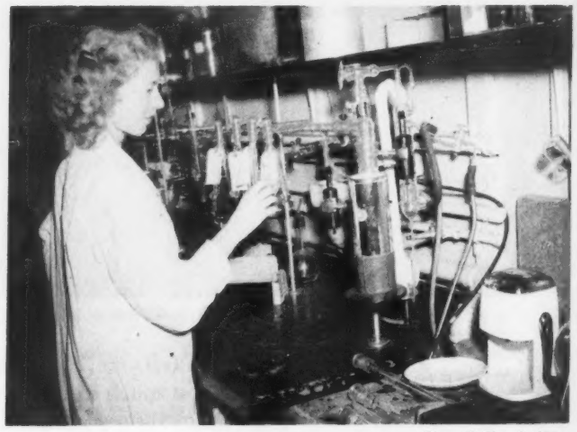
Sulfur as a Tracer Atom

Research into organic processes has been done with isotopes of elements other than the basic carbon, hydrogen and nitrogen. Phosphorus, iodine and sulfur have been incorporated into tracer molecules. Inorganic compounds of elements such as tellurium have also been used to trace the elimination of foreign compounds and poisons.

Extensive work has been done using radioactive sulfur 35, which is available in the form of inorganic sulfates.

In one set of studies, barium sulfate was converted to a sulfide, and then, through potassium acid sulfide, was used to make benzyl mercaptan (Figure 10). From this was synthesized radio methionine containing radioactive sulfur.

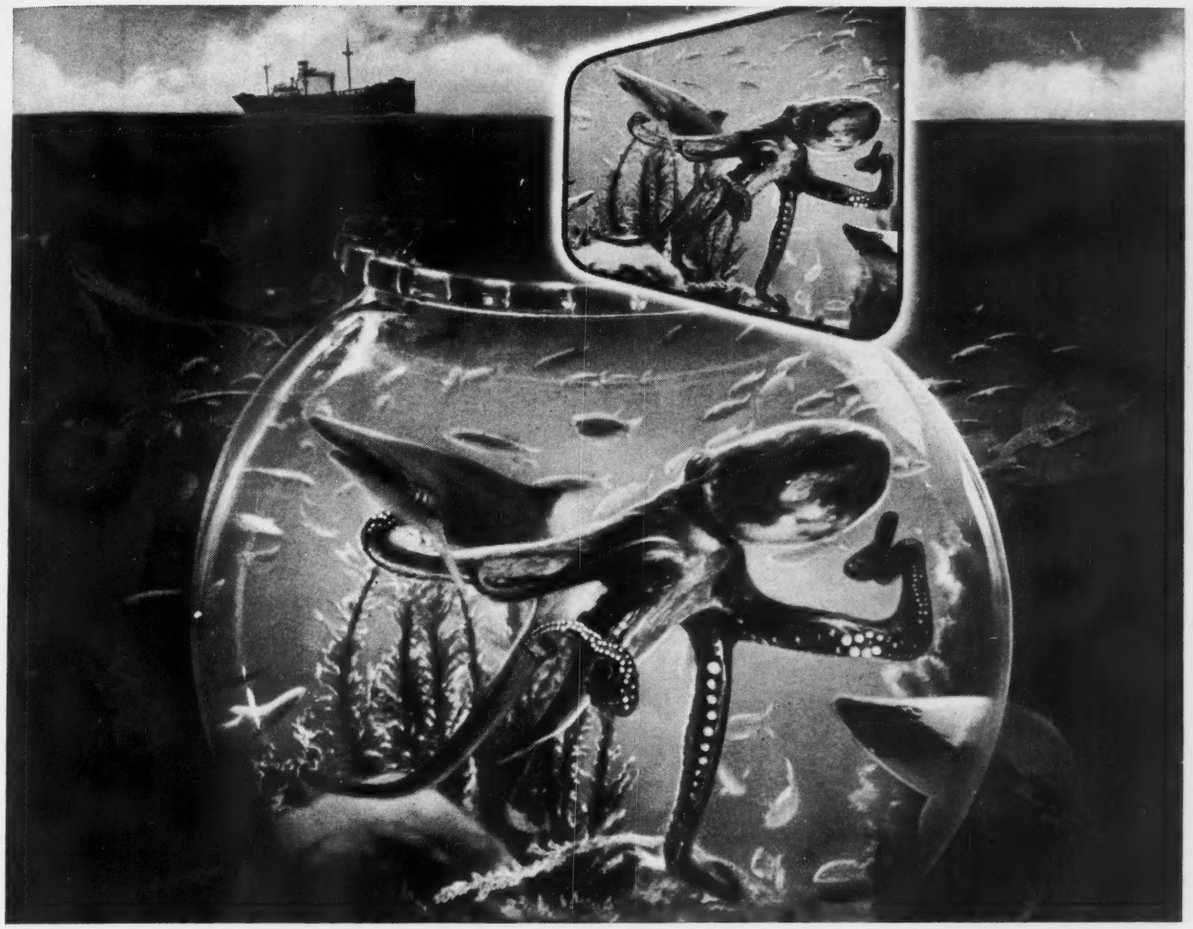
This radio methionine was fed to dogs whose livers had been excised in order to find what effect that organ has on protein synthesis. By tracing the radioactive sulfur, it was shown that, in this case, the liver is not entirely necessary for the synthesis of tissue protein. When compared with that of unharmed animals, the tissue rotein of the liver-less dogs contained an equal amount of radioactive sulfur. However, other forms of protein, such as plasma protein and globulin, showed greatly reduced activity compared to that of normal dogs, showing that the liver has an important connection in the synthesis of these substances.



Kenneth Kopple, '51

The preparation of nitrogen samples for isotope analysis

Work with isotopically tagged molecules has been going on at a rapid pace. Each new set of biological and chemical literature contains many reports of new advances. Now that the recent war has provided the impetus for greater nuclear research, isotopes, radioactive and stable, are rapidly becoming one of the handiest tools of the biological chemist.



Exploration of ocean depths is made possible by RCA Image Orthicon television camera.

The ocean is a "goldfish bowl" to RCA Television!

Another "first" for RCA Laboratories, undersea television cameras equipped with the sensitive RCA Image Orthicon tube were used to study effects of the atom blast at Bikini . . .

There may come a day when fishermen will be able to drop a television eye over the side to locate schools of fish and oyster beds . . . Explorers will scan marine life and the geology of the ocean floor . . . Undersea wrecks will be observed from the decks of ships without endangering divers.

With the new television camera, long-hidden mysteries of the ocean depths may soon be as easy to observe as a goldfish bowl—in armchair comfort and perfect safety.

Exciting as something out of Jules Verne, this new application of television is typical of research at RCA Laboratories. Advanced scientific thinking is part of any product bearing the name RCA, or RCA Victor.

When in Radio City, New York, be sure to see the radio and electronic wonders at RCA Exhibition Hall, 36 West 49th Street. Free admission. *Radio Corporation of America, RCA Building, Radio City, New York 20.*

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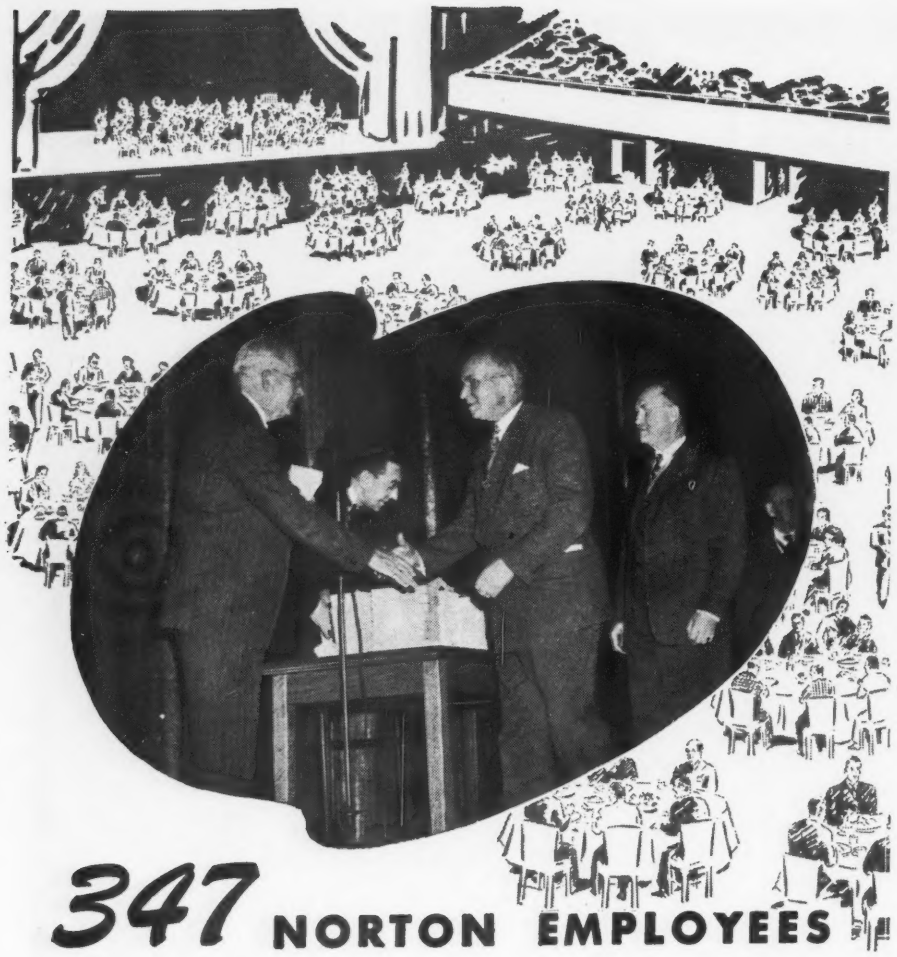

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ON December 6 over 1300 Norton men and women were company guests in Worcester's Municipal Auditorium for the 26th annual presentation of Service Awards:

212 — 10 years service
47 — 15 years service
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29 — 35 years service

Approximately 10% of all Norton employees have been with the company 25 years or more.

These figures attest to the truth of the phrase so often heard in Worcester, "Norton's is a good place to work"

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WHY MATTER IS ELASTIC

(*Continued from page 66*)

tions in appropriate proportions prior to spreading, a highly elastic film results.

Perhaps even more interesting than the study of natural rubber, is that of guttapercha which, although chemically identical with it, shows no elasticity up to 65° C. So far, the only explanation which has been offered for this difference is based on the evaluation of X-ray diffraction patterns. This has shown that guttapercha is polyisoprene of the *trans*-, rubber of the *cis*-configuration. It is the difference in the location of the methyl group which is held responsible for the lack of elasticity in guttapercha at normal temperature. That it becomes elastic at temperatures above 65° C. has been attributed to a change in its molecular configuration and to the increase in molecular oscillation. Quite recent fractionation studies gave the same results as those reported for rubber. The low molecular weight fractions exhibit no elasticity, even at 65° C. The high molecular fraction is non-elastic and brittle. Ultramicroscopic studies of total guttapercha revealed that films deposited at room temperature yielded irregular structures with ragged edges, but if they were heated to 65° C., the formation of liquid zones became immediately evident (Figure 6).

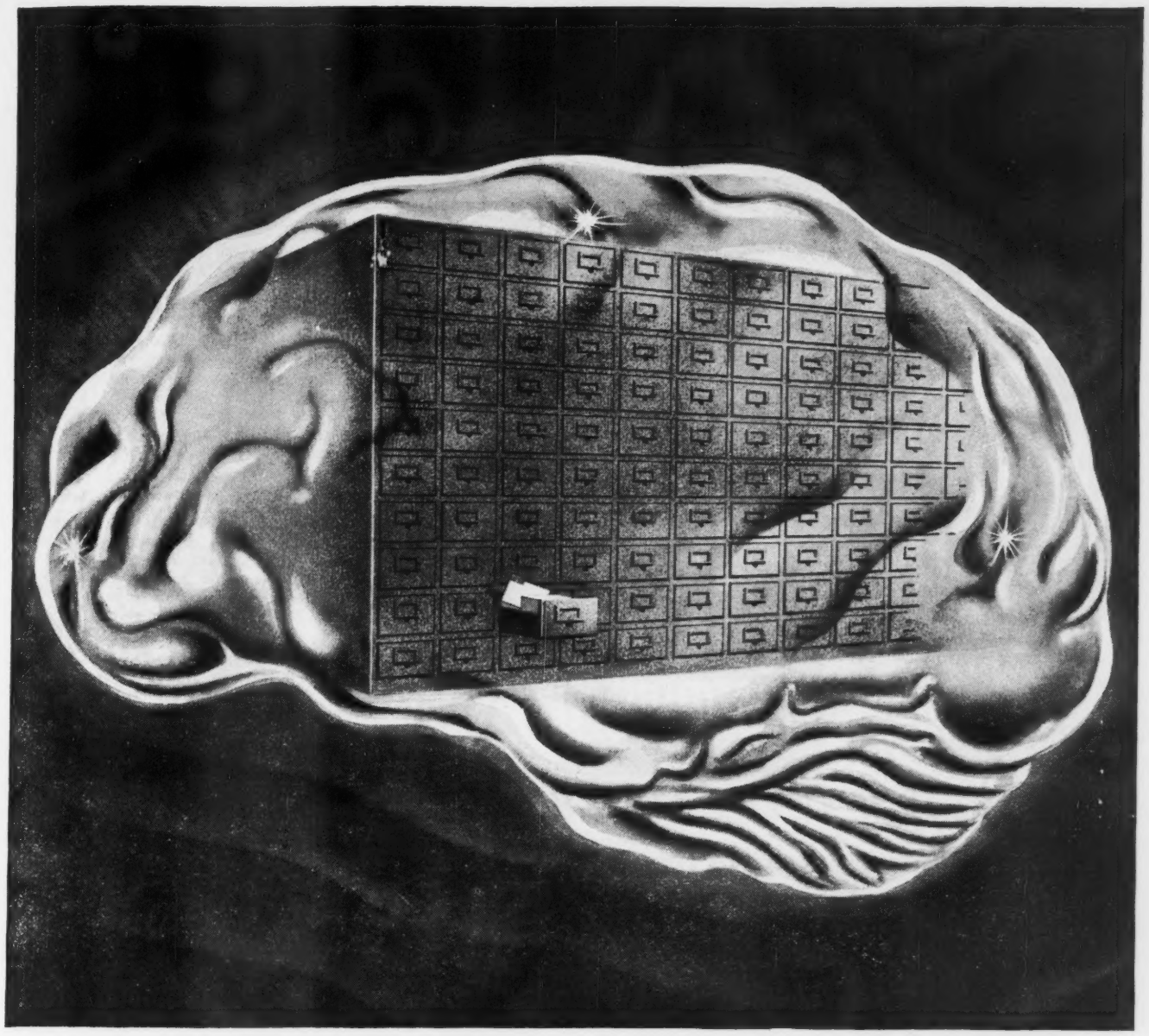
All these visual facts certainly offer ample evidence that elasticity of rubber and its homologues is not a property specific to them alone.

The day has come when one can actually see what the two-phase theory for the elasticity of rubber postulated twenty years ago.

A theory is only valid, however, if it can be upheld and made as general as possible. In this case we have already many supporting evidences. Polyisobutylene, for example, is a viscous liquid if present as a polymer of low molecular weight. The high molecular weight polymer is hard and even brittle. A mixture is elastic. The same holds for butyl-rubber, the copolymer of isobutylene and isoprene, or butadiene.

Polystyrene can be made fairly elastic at somewhat elevated temperatures by using a mixture of low and high molecular weight polymer. The same has been found to be true with polyvinyl-chlorides. In both cases ultrami-

(*Continued on page 88*)



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Some day you are going to want to know something that you won't have learned in college. And won't find in books.

You are going to consider using aluminum for some purpose where the engineering isn't all spelled out for you. You'll want facts about aluminum that you can apply to your problem; and guidance in using them.

When that happens, remember to call on the brains that have stored up more knowledge of aluminum than you can find anywhere else. For 59 years this brain has been gathering facts and experience in making aluminum useful in thousands of ways.

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PRECISION INSTRUMENTS

PUSH BUTTON STEEL MILL

(*Continued from page 75*)

to 54 inches wide and nine inches thick. The normal annual production of the plate mill is 806,400 tons of steel.

Although the Homestead plant of the Carnegie-Illinois Steel Corporation is one of the largest steel mills in the United States, its size alone is not the primary reason that the plant attracts as much attention as it does. The outstanding feature of the mill is the extent to which remote control has been utilized in the handling of steel. The Homestead slabbing mill, in which the entire manufacturing process from the soaking pits to the slab yards is controlled from two main pulpits, is the prime example of this feature. Future steel mill designs will be greatly influenced by the lessons the steel industry has been taught by the Homestead plant. The often dreamed of day of the automatic steel mill is still far in the future, but the Homestead plant is a decided step in that direction.

WHY MATTER IS ELASTIC

(*Continued from page 86*)

croscopic studies revealed the formation of liquid zones after the solvent had evaporated, the film disrupted, and the resulting threads placed under a certain amount of tension. This causes alignment of the long molecules, and a separation of the low molecular weight fraction.

So far, we have only discussed systems in which both phases were of identical chemical composition, differing only in their molecular weight. Elasticity can, however, be achieved when one phase can be solvated by the other. Dry gelatin, for example, is nonelastic. If the gelatin is soaked in water, however, so that it forms a gel due to the solvation of the gelatin molecules, it becomes elastic to some extent. This phenomenon is even more pronounced with alkali silicates and gels obtained from certain types of clays.

All these findings have now offered definite proof that elasticity depends primarily on the colloid chemical properties of the system and only to a much lesser degree on its strict chemical composition. Our new ultramicroscopic technique has offered the first visual proof why matter is elastic and has thereby thrown the door wide open for studying this property of matter in great detail; thus it will be, from now on, much easier to improve the elastic properties of certain substances, or to synthesize new ones.

Editor's Note: Dr. Hauser is an Associate Professor of Chemical Engineering at M. I. T. Dr. Le Beau is Director of Research at the Midwest Rubber Reclaiming Company.

In Next Month's

T·E·N

Television comes to Tech

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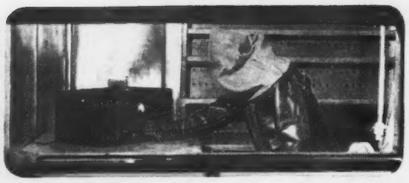
Testing a Crystal frequency calibrator at 76° below zero in the Frick Refrigerated Laboratory of Bendix Radio, Towson, Md.



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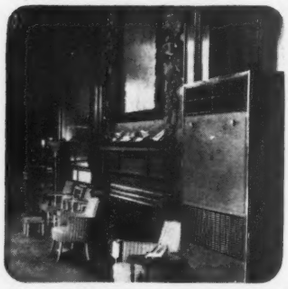

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"Something extra" is typical of Okonite production techniques and research procedures. That something extra, multiplied many times spells leadership . . . reflects Okonite's engineering background as pioneers in electrical wires and cables. The Okonite Company, Passaic, New Jersey.

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OKONITE

OKONITE SINCE 1878

insulated wires and cables

HOW MANY UNIVERSES?

(*Continued from page 72*)

tances show that these clusters are much farther out than the average star. They also, along with the Milky Way, are unresolvable by the naked eye into individual stars. Thus it seems that the individual stars join with our Sun in forming one of these Globular Clusters, and consequently, the stars that one sees in the night sky belong to just one small globule out of the hundreds that form the biscuit universe, bounded by the Milky Way.

Taken as a whole, this universe is called the Galactic System. When observed as a separate entity, it exhibits the following properties, the significance of which will be made clear in a moment:

1. It is finite in extent. This is evident from the fact that there are regions beyond which even the most powerful telescopes cannot detect stars. It also follows from the quite valid assumption that an infinite system would make the night sky appear as an unbroken blaze of light, rather than the observed pin point effect.

2. It contains billions of stars.

3. These stars are grouped together in a number of Globular Clusters.

4. It has its maximum density in a region whose thickness is small compared to its diameter, and whose principal plane is that of the Milky Way.

5. It rotates about its center.

6. Its diameter is about one hundred thousand light years.

7. A thin haze of stars envelops it, giving it the shape of a greatly oblate spheroid.

In the Northwest section of the night sky, between the constellation Cassiopeia and the Square of Pegasus, there lies the constellation Andromeda, famous for a little blob of light near its center, just visible to the naked eye. With the aid of a telescope, this blur blazes into one of the most awe inspiring sights in the night sky — the Spiral Nebulae of Andromeda. It is one of a class of celestial bodies, and is unique in that it can be seen with the naked eye. Indeed, it is one of the few that can be seen at all without the aid of the most powerful telescopes.

Each improvement in telescopic technique has brought numbers of these Spiral Nebulae into view, until now literally millions are known. They are all far away from our Solar System, and far away from each other. Light from Andromeda, one of the nearest, takes nine hundred thousand light years to cross space and land on the Earth. Thus the light from Andromeda that we see in the night sky left it before man ever existed on Earth, and is just now getting here! Yet, Andromeda is the second nearest of all the known Spiral Nebulae.

Photographic examination of these nebulae show that they are composed of stars, and that these stars tend to gather in clusters. Treating such nebulae as separate entities, the following are observed:

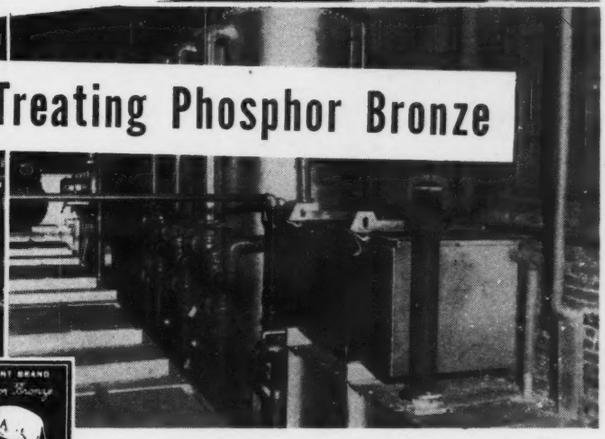
1. They are finite in extent.
2. They are made up of countless numbers of stars.
3. They are shaped like a flattened disk.
4. They rotate about a center.
5. Their sizes are such that an electron, travelling at the speed of light, would take hundreds of thousands of years to traverse a diameter. (*Continued on page 94*)

Continuous homogenizing* furnace in which phosphor bronze is prepared for cold rolling.

Continuous GAS Furnaces Increase Production

Reduce Cost of Heat Treating Phosphor Bronze

Roller hearth radiant tube heated furnace using prepared atmosphere for bright annealing.



Atmosphere generating equipment used with bright annealing furnace.

Customers of Phosphor Bronze Smelting Company, 2200 Washington Ave., Philadelphia, started the whole thing—they demanded more Elephant Brand Phosphor Bronze products than the company could produce by former methods of heat treating.

So company production engineers, already familiar with GAS and Gas Equipment, specified the modern method of heat treating—with continuous, automatically-controlled, Gas Furnaces, with integral prepared atmospheres.

Here are the processes . . .

Process—*Homogenizing—a method of heat treating to develop uniform grain structure in phosphor bronze billets prior to rolling, while relieving casting strains.
Temperature—1200° F.
Cycle—6 hours
Furnace Capacity—2000 lbs. per hour

Process—Annealing of bars and sheets in a prepared-atmosphere furnace to retain brightness while relieving stresses set up during rolling or drawing operations.
Temperature—1200° F.
Cycle—40 minutes to 3 hours, varying with stock size
Furnace Capacity—5000 lbs. per hour

Here are the results . . . .

1. Pickling process eliminated
2. Production increased 80%
3. Uniformity of heat treatment assured by automatic control
4. Annealing and homogenizing costs reduced over 50%
5. Working conditions improved

Throughout industry modern Gas Equipment has established cost-cutting and time-saving records wherever GAS heat treating methods and machinery have been integrated in production-line processes.

AMERICAN GAS ASSOCIATION

420 LEXINGTON AVENUE, NEW YORK 17, N. Y.

MORE AND MORE... THE TREND IS TO GAS FOR ALL INDUSTRIAL HEATING

Let's start at the ashes... The plant is gone, the records are gone, all orders are canceled. That much you can see with your own eyes. But losses are actually far greater — losses you must "see" with your mind.

There is the loss in replacement — for, regardless of insurance it is impossible to replace destroyed buildings and equipment today at original cost. There is the loss of an *industry* to the community; loss of *jobs* to employees; frequently loss of *life*. And remember lost *customers* whom no amount of indemnity will ever bring back. Most of all, remember this — regardless of insurance, *2 out of every 5 burned-out businesses never resume operations.*

All of this can happen — but it need not ever happen. For there is a system of Grinnell Protection for every kind of fire hazard, ready to control fires quickly, effectively, at the source, no matter where fire strikes. If property is unprotected against fire, owners are paying through insurance for Grinnell Protection — *why not have it?*

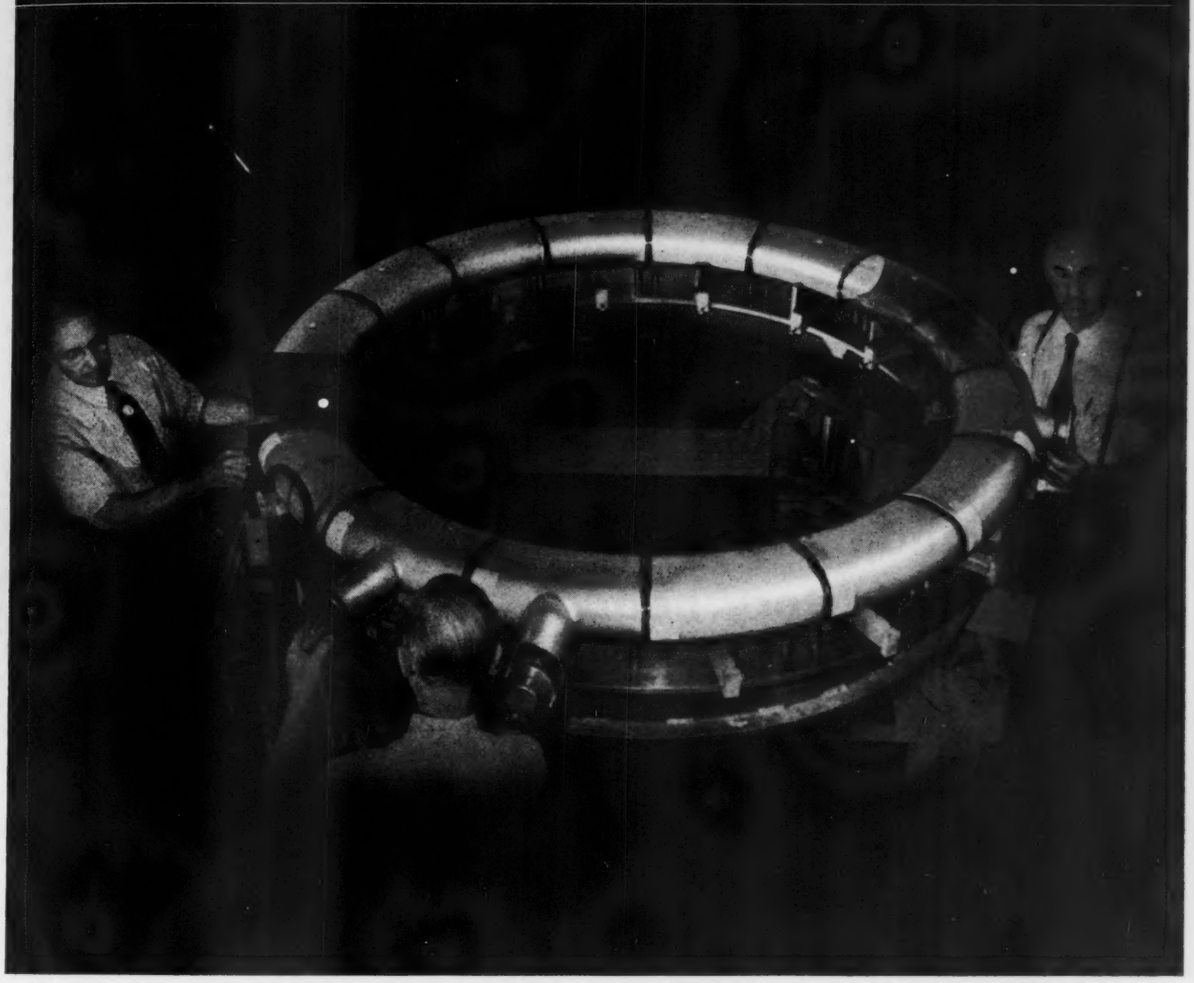
Grinnell Company, Inc., Providence 1, R. I.
Branch Offices in Principal Cities.

GRINNELL
FOUNDED 1850

Automatic Fire Protection Systems

Engineering graduates have found attractive opportunities with Grinnell.

The glass doughnut that made headlines . . .



ON January 26, 1946, newspapers carried front page stories about the new and amazing 100 million volt "betatron". The heart of this instrument that enables scientists to peer more deeply into steel castings to discover flaws, is a giant hollow glass "doughnut." With the betatron, men in the field of nuclear research have already made startling discoveries in the investigation of atomic energy.

The making of this giant glass tube called for glass research knowledge and glass-making skill of the highest degree. And Corning was ready with the right combination of both. Each of those "doughnut" sections you see in the picture had to be built to the most exacting dimensional tolerances.

Science and industry have learned to expect Corning to come through with the answer to any glass problem. For instance, Corning produced the world's largest piece of cast glass . . . the 200″ telescope mirror for famed Mt. Palomar. And when all other materials failed to do the job of handling hot corrosive acids, Corning made glass pipe and glass pumps that work without a hitch or replacement for years. Thermometer tubing . . . miles and miles of it . . . with a bore only 1/8 the diameter of a human hair is just an everyday job at Corning.

With more than 50,000 different glass formulae to draw on, Corning scientists and glass workers have adapted glass to thousands of different jobs . . . some simple, some as complicated as the betatron. But in every instance glass is used because it does the job best. And you'll find after graduation that a knowledge of glass may help you do a better job. So why not keep Corning in mind. We'll be ready to help you all we can. Corning Glass Works, Corning, N.Y.

CORNING
means
Research in Glass

MAKERS OF PYREX OVENWARE AND FLAMEWARE AND 37,000 OTHER GLASS PRODUCTS

College Engineering Publications—Nov. Dec.
Batten, Barton, Durstine & Osborn, Inc.
P O. Bflo. 7-582 KPC 9-10-47
Final Proof 7 x 10

A guide for fishermen... and factory heads

FISHING rod guides (like the one above) and bearing surfaces in reels can now wear virtually forever.

Why? Because the hardest metal made by man is adaptable for use at the wear points. This super-hard metal is Carboloy Cemented Carbide.

And the same, almost incredible wear-resisting qualities of Carboloy are equally effective in thousands of manufacturing applications and product parts throughout industry. Take textile plants, for example:

Textile parts last years longer

In one mill, Carboloy nylon guides have lasted three years and are still in use! *Steel guides lasted only two months.* And so it is with slitter knives, carding pins, needles, jute and yarn guides . . . all tough spots for ordinary metals but duck soup for Carboloy.

Vital to all industries

Carboloy is held by authorities to be *one of the ten most important industrial developments of the past decade* . . . a guide to cost-minded factory heads everywhere . . . because:

1. **Carboloy commonly triples the output of both men and machines,**
2. **Regularly increases the quality of products, and**
3. **Cuts, forms or draws all alloys with accuracy and speed previously unknown.**

A challenge to you

The odds are 10 to 1 that Carboloy—the amazing metal of many uses—can be put to work profitably in your plant by our engineers. Write

Carboloy Company, Inc., Detroit 32, Mich.

© 1947 CARBOLOY CO.

CARBOLOY®

CEMENTED CARBIDE

THE HARDEST METAL MADE BY MAN

HOW MANY UNIVERSES?

(*Continued from page 90*)

6. A thin haze of star stuff envelops them, giving them the shape of a greatly oblate spheroid.

These, however, were the observations on our own Galactic System. It is just possible, then, that our biscuit universe is not a universe at all, but rather one of many millions of Star Cities, called the Spiral Nebulae.

Let us recapitulate then, and try to see just where we on Earth are in the Scheme of Things. An outline would read like the following:

1. The Earth is but one of nine planets encircling the Sun.

2. The Sun is a member of a Globular Cluster, and is about three hundred light years from its center.

3. This Globular Cluster is a member of our Galactic System, and is about fifty thousand light years from its center.

4. The whole Galactic System may be one of millions of Star Cities, and is a member of who knows what?

These Star Cities all exhibit the Doppler effect, by a shift towards the red end of the spectrum, indicating a motion away from us. Eddington calls these Star Cities "Island Universes," since he has shown that if these Spiral Nebulae continue to recede at their present large velocities, a time will come when their mutual recession will be too great for even light to pass from one to another, and they will be truly isolated "Island Universes," completely unknown and unknowable to man — conceivable only in the mind of some celestial creature who doesn't need light to see things.

MARCH 1948

T·E·N'S

NUCLEAR ENGINEERING

ISSUE

Watch for It!

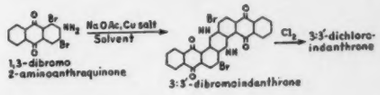
DU PONT Digest
For Students of Science and Engineering

Development of dyes requires both physical and organic chemistry

The synthesis of a new dye in the laboratory or even the development of a manufacturing process from that synthesis may still be a long way from the realization of the full potentialities of the new compound as a coloring material. This is illustrated by the commercial history of the exceedingly fast bright blue dye indanthrone and its halogen derivatives.

Indanthrone was the first known anthraquinone vat dye and has led tonnage sales of vat dyes in the U.S. since its introduction, despite the commercial use of well over 200 types. In 1901, Bohn first synthesized indanthrone by KOH fusion of 2-aminoanthraquinone, but the yields obtained were in the range of only 25-30 per cent. Because of the industrial importance of indanthrone, and the low commercial yields obtained by the original fusion procedure, a great deal of research time has been spent in its study.

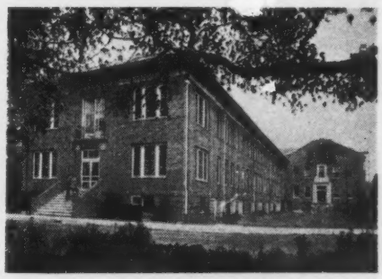
Several U.S. patents record the fact that Du Pont organic chemists have made outstanding contributions in this field, particularly by developing the intercondensation of 2 moles of 1,3-dibromo-2-aminoanthraquinone and replacing the bromine by chlorination to give 3:3′-dichloroindanthrone ("Ponsol" Blue).



This fixes the chlorine in the desired positions to give a product with greater bleach-fastness than indanthrone and minimizes extraneous substitution that always accompanies direct chlorination of indanthrone. The commercial yields of 3:3′-dichloroindanthrone now being obtained by Du Pont are markedly greater than those obtained by Bohn and his workers.

It is just as important, however, that a water-soluble dye be made in a physical form that gives optimum shade and working qualities, such as perfect dispersion, freedom from specks, rapid reducibility and storage stability. A significant Du Pont contribution to the production of vat dyes in optimum physical form is called "turbulent flow drowning." In this procedure, the color is dissolved in strong H_2SO_4 and then diluted by a large volume of water in a constricted tube. High turbulence is maintained during dilution and produces uniform dye particles.

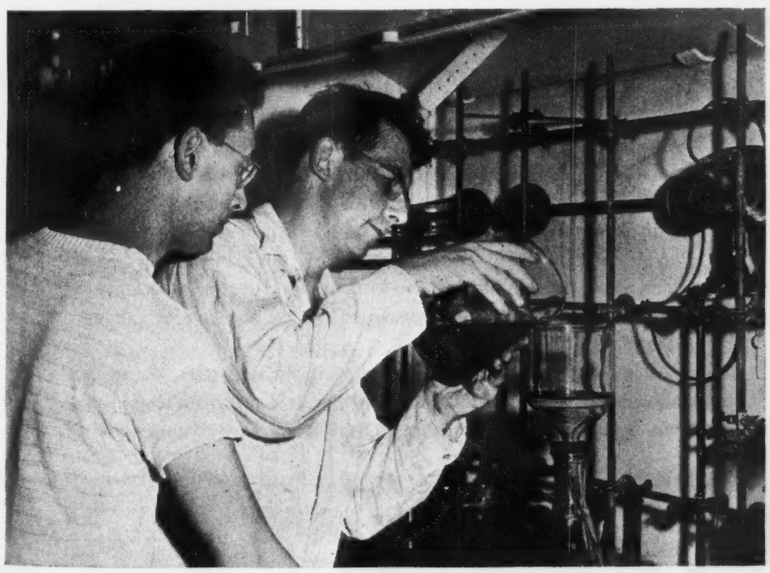
In this development the work of physical chemists and physicists, aided by electron microscopy, ultra-centrifuging, infrared and ultra-violet spectrometry and other modern techniques, was of major importance.



One of the three wings of the Jackson Laboratory, where a large portion of the basic research on dyes is carried on. The new $1,000,000 addition on the right is nearing completion.

The conversion of laboratory findings to a plant operation often presents unique and difficult problems that require unusual ingenuity on the part of chemists, chemical, mechanical and electrical engineers. The work on the indanthrones was no exception. The outstanding commercial success of "Ponsol" vat colors, typified by "Ponsol" Blue is one example of the results achieved through cooperation of Du Pont scientists.

★ ★ ★



W. R. Remington, Ph.D., University of Chicago, 1944, and S. N. Boyd, Ph.D., University of Illinois, 1945, working on a dye research problem.

Questions College Men ask about working with Du Pont

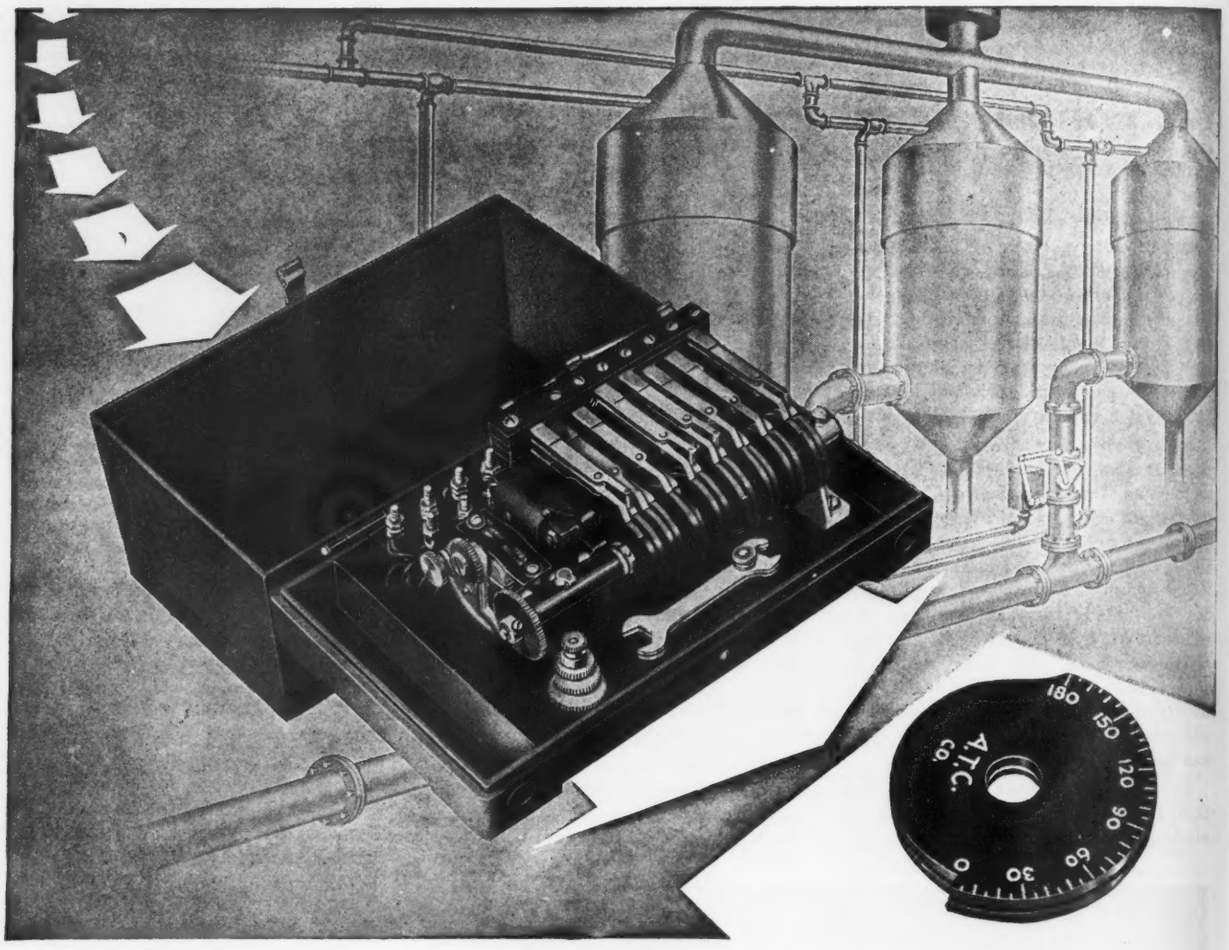
WILL I GET LOST IN A BIG COMPANY?

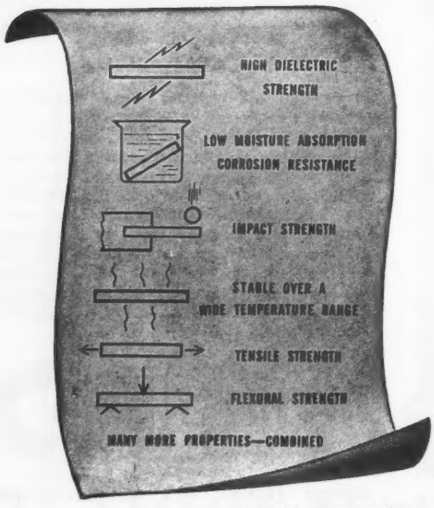
The organization of Du Pont is unique in that each of its ten manufacturing departments and two technical staff departments is responsible for its own operation. Furthermore, new chemists and engineers work in small groups under experienced supervisors. Du Pont's group system assures men of interesting and friendly working conditions plus the broad avenues of promotion that go with size. Write for the new booklet, "The Du Pont Company and the College Graduate," 2521 Nemours Building, Wilmington 98, Delaware.

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
... *THROUGH CHEMISTRY*

Plastics where plastics belong— using insulating and printing qualities





OUR TYPE of plastics, Synthane, has a combination of mechanical, chemical, and electrical properties that fit it for a host of useful applications. It is corrosion and moisture resistant, dense, structurally strong, and may be easily worked. An excellent electrical insulator, Synthane is extremely light (about ½ the weight of aluminum).

A good example of the use of laminated plastics is this timing device which uses Synthane for the cams in the timer. Heart of an automatic system, the Cam Timer is designed to control the flow of exhaust gases to a stack.

Aside from its outstanding insulating qualities, letters, numerals, and symbols may be easily and clearly printed on Synthane by our Synthographic process. Synthane Corporation, Oaks, Pennsylvania.

SYNTHANE

SYNTHANE TECHNICAL PLASTICS • DESIGN • MATERIALS • FABRICATION • SHEETS • RODS • TUBES • FABRICATED PARTS • MOLDED-MACERATED • MOLDED-LAMINATED

Her compact passed 65 screen tests

Be it made of gold, silver or "brass", a compact has to pass a lot of "screen tests" on its way from the earth to its user.

Ore is screened a score of times before it becomes metal. Silica goes through a battery of screens to become a mirror. And talcum is forced through a long series of fine-mesh screens before it acquires that caressing smoothness that is demanded by our exacting fair sex.

Yet, because this is America, compacts. which are beyond the means of women living in countries that decry our free enterprise system, are sold in dime stores, available to millions.

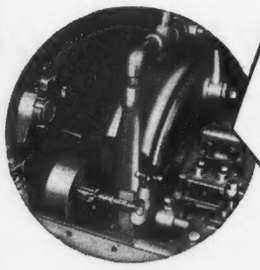
Roebling products play a leading part in this mass production. Roebling wire screens meet all materials under all conditions. In one case they pass rocks as big as melons. In another they reject dust as fine as pollen.

Made of steel rods as thick as your thumb, or woven of stainless as fine as hair, Roebling screens serve industry in a hundred ways—on a thousand jobs.

JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
Branches and Warehouses in Principal Cities

A CENTURY OF CONFIDENCE **ROEBLING**

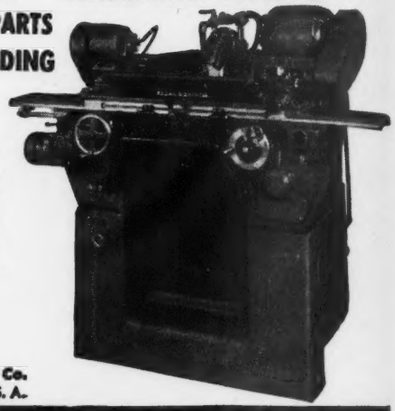
National Electric Products Corporation
Pittsburgh 30, Pa.



.0002" TOLERANCE
PRACTICALLY PERFECT ROUNDNESS
NO. 2 MICRO-FINISH

– this is No. 5's stated performance on grinding drum shafts – one of the most vital parts of a precision bombsight – produced in lots of 2000.

SUCH ACCURACY – CONSISTENTLY REPEATED – SPEEDS SMALL PARTS PRECISION GRINDING



☆

No. 5 Plain Grinding Machine – made in two sizes – 3"x12" or 3"x18". Work speeds and table speeds are designed for diameters up to about 1".

Brown & Sharpe Mfg. Co.
Providence 1, R. I., U. S. A.

BROWN & SHARPE

ANSWERS TO LAST MONTH'S

Can You Do It?

(*Answers next month*)

Problem 1: The time schedule is as follows:

Action	*Minutes*
Load bread number 1 in side A	.05
Load 2 in side B	.05
Wait	.45
Flip 1 in side A	.02
Wait	.03
Unload 2 from side B	.05
Load 3 in side B	.05
Wait	.37
Unload 1 from side A	.05
Load 2 in side A	.05
Wait	.03
Flip 3 in side B	.02
Wait	.45
Unload 2 from side A	.05
Unload 3 from side B	.05
Total	1.77

The solution to the second problem is somewhat involved and will not be printed here. Procedure similar to the above can be used to find the answer, however.

J. W. W.

RADIO HAMS' GET-TOGETHER

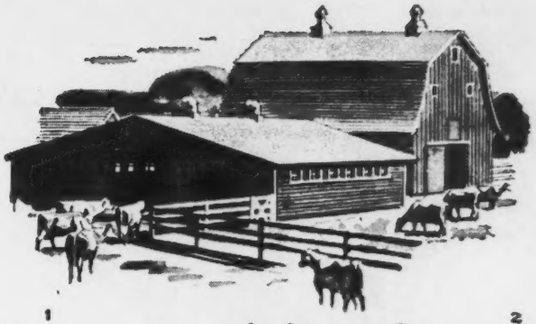
(*Continued from page 70*)

ordinate indicator is ideal for studying this type of phenomenon. To show one application of the instrument the exhibit displayed a conventional automobile six-cylinder ignition distributor, driven by an electric motor, with the indicator arranged so as to show the effect of varying degrees of spring tension on the distributor contact points. Figure 2 shows the display set-up, and Figure 1 provides a close-up view of the indicator. Included in Figure 1 are diagrams of three typical screen patterns for the investigation of distributor spring tension as described above. Pattern A is the pattern encountered when there is excessive point bouncing in the distributor; pattern B shows the effect of moderate bouncing; and pattern C shows the configuration which indicates proper adjustment of the spring tension.

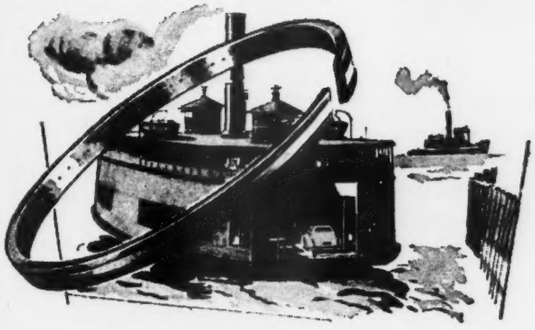
The indicator is essentially a cathode ray oscillograph with a circular time base on which the signal being studied produces a radial deflection. The circular time base is generated by a two-phase sine wave generator which is coupled directly to the mechanism being studied. Thus, complete synchronization between the indicator and the machine under test is automatically assured. The features contained in the oscillograph should make its potential usefulness evident to all.

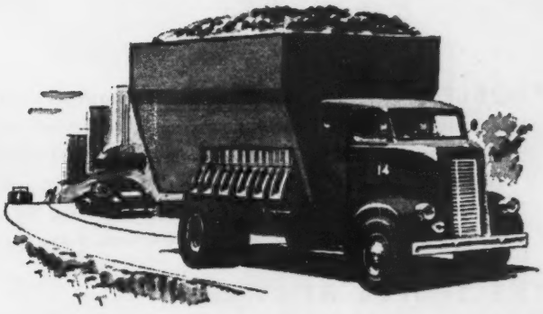
Another display which attracted many hams was the McElroy electronic tape communicator. The model on display was a high speed modification of conventional tape recorders. In the unit, the sender broadcasts the message just as a standard C. W. transmitter would do. The transmitting unit radios

(*Continued on page 100*)



When you admire a beauty[1] . . . or visit a farm[2] . . .





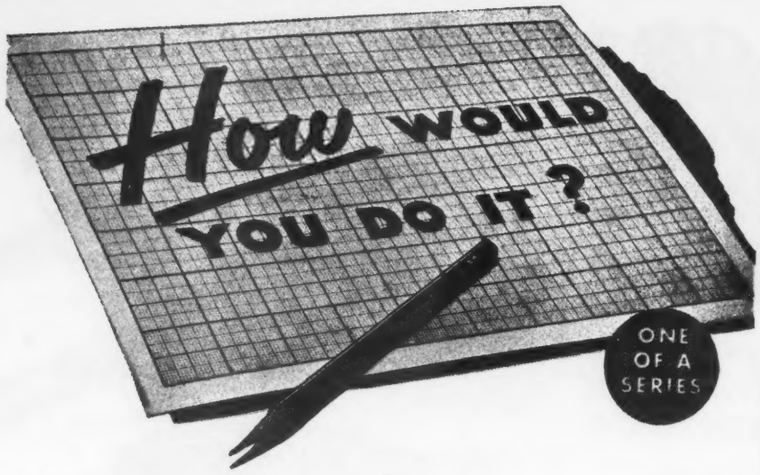
ride on a ferry[3] . . . . . or order some coke[4] . . .

swallow an aspirin[5] . . . . or turn on the light[6] . . .

the chances are, you are coming in contact with Koppers engineering or chemical skills.

1. Koppers chemicals for use in cosmetics. **2.** Farm structures made of lumber pressure-treated by Koppers for long life. **3.** Koppers American Hammered Piston Rings for marine engines. **4.** Coke from Koppers-built ovens. **5.** Koppers chemicals for use in medicines. **6.** Koppers Fast's self-aligning couplings, widely used in power plants. All these are Koppers products . . . as well as scores of others that help to increase our comfort, guard our health, enrich our lives. All bear the Koppers trade-mark, the symbol of a many-sided service . . . and of high quality. Koppers Company, Inc., Pittsburgh 19, Pa.

K
KOPPERS



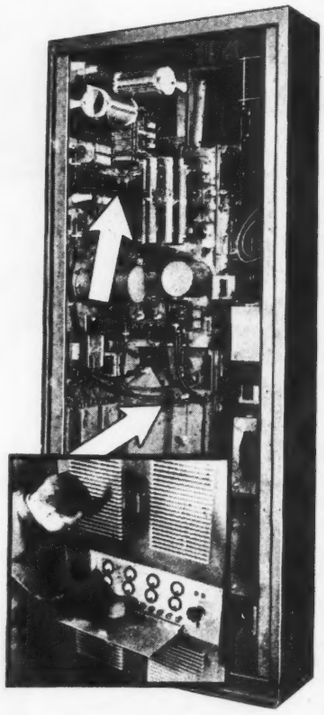
PROBLEM— You're designing a radio broadcast transmitter. The circuit includes condensers and other variable elements which must be adjusted by the operator. You want to place these elements for optimum circuit efficiency and where they will be easy to assemble, wire, and service. At the same time, you want to centralize the control knobs at a point convenient to the operator. How would you do it?

THE SIMPLE ANSWER

Use S.S.White remote control type flexible shafts to couple the variable elements to their control knobs. This leaves you free to place both the elements and the knobs anywhere you want them. And you get control that is as smooth and sensitive as a direct connection because S.S.White remote control flexible shafts are engineered expressly for this kind of service.

★ ★ ★

This is just one of hundreds of remote control and power drive problems to which S.S.White flexible shafts provide a simple answer. That's why every engineer should be familiar with the range and scope of these "Metal Muscles" for mechanical bodies.



Here's how one big radio manufacturer did it.

WRITE FOR BULLETIN 4501

It gives essential facts and engineering data about flexible shafts and their application. A copy is yours for the asking. Write today.

S.S.WHITE INDUSTRIAL DIVISION
THE S. S. WHITE DENTAL MFG. CO. DEPT. C, 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED RESISTORS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises

RADIO HAMS' GET-TOGETHER

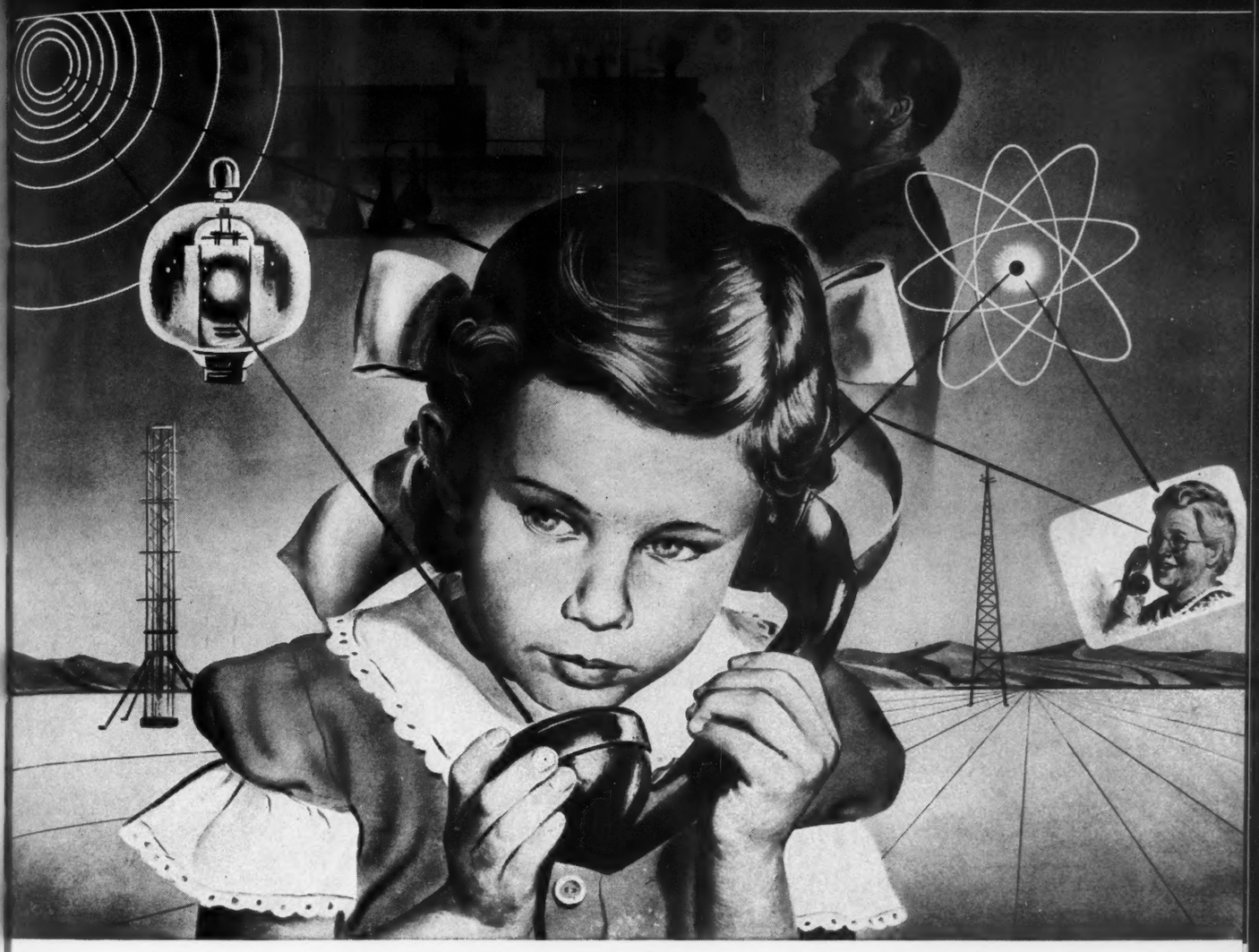
(*Continued from page 98*)

the signal to the receiving unit which marks the incoming code on a paper tape by means of a broken line. The tape is then automatically fed through a channel over a typewriter keyboard at any predetermined speed. A typist reads the message as the tape moves along and types it simultaneously. Figure 3 shows the receiving assembly of the system. The unit on the right is the recorder which marks the code on the tape; in the center is the typewriter with the tape passing over the keyboard; and on the left is the tape puller, the device which pulls the tape over the typewriter and rerolls it. If one has a message all ready recorded on tape and wishes to retransmit the message, it is not necessary to manually send it in Morse code again. The tape is merely fed through a photo keyer which transmits the code from the line on the tape. The speed of the communicator is, of course, largely dependent upon the ability of the typist to read the tape and transcribe the message. The usual operational speed of the unit is three hundred words per minute, although the machine is mechanically capable of recording seven hundred words per minute, a great improvement in speed over older types of tape communicators.

Another new device which attracted much attention, although it is not particularly useful in amateur radio work, was the Pilotuner. The Pilotuner is an instrument which can be attached with ease to any A. M. receiver and which will enable the A. M. set to receive F. M. broadcasts. Because the unit is so simple to attach to any ordinary radio and sells for less than thirty dollars, the Pilotuner should become very popular.

The lectures and displays described above all helped to make the Tenth Annual Boston Hamfest a great success. It would probably be safe to say that everyone who attended the hamfest enjoyed himself. Plans for an even more successful Eleventh Boston Hamfest are now under consideration, and such an event will have no more enthusiastic supporters than the people who attended the 1947 Hamfest.

"—mountains are leveled and oceans bounded by the slender force of human beings"—SAMUEL JOHNSON



Why communications get better all the time

YOUR VOICE girdles the globe in one-seventh of a second.

It travels at 186,000 miles per second—the speed of light—thanks to the telephone and radio. And by television, so do the pictures of any event as it occurs.

What has made this blinding speed possible? What has given us these "ringside seats"... to see, to hear, to share in the headline news of the day?

The answer: Greater knowledge of electronic waves and better materials to harness them. For example, the vacuum tube—heart of radio or television—depends upon the greatest possible absence of air or other gases—a high vacuum. Most of the air is pumped out before the tube is sealed. Then a tiny bit of barium, called a *"barium getter"* is flashed inside of it by electricity. This captures the remaining air and gives a nearly perfect vacuum.

Unending research and engineering have also provided finer plastics for insulation, purer graphite and carbon for electronic devices... and a host of other basic materials that help shave the speed of communications to the tiniest splinter of a second.

Producing these better materials and many others—for the use of science and industry and the benefit of mankind—is the work of the people of UNION CARBIDE.

FREE: *You are invited to send for the illustrated booklet, "Products and Processes," which describes the ways in which industry uses UCC's Alloys, Carbons, Chemicals, Gases and Plastics.*

UNION CARBIDE
AND CARBON CORPORATION
30 EAST 42ND STREET UCC NEW YORK 17, N. Y.

Products of Divisions and Units include

LINDE OXYGEN • PREST-O-LITE ACETYLENE • PYROFAX GAS • BAKELITE, KRENE, VINYON, AND VINYLITE PLASTICS
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. . . a great name in research with a big future in **METALLURGY**

BABY'S BLOCKS AND B-29'S USE G-E PERMANENT MAGNET POWER

Nursery toys and Super-Fortresses have something in common. It's their use of General Electric permanent magnets. And there are thousands of other products in many and varied industries which employ these remarkable magnets to exceptional advantage.

What is it that makes G-E permanent magnets so readily adaptable to the needs of motors and generators, control devices, games and novelties, radio and communication equipment, meters and instruments, and mechanical appliances? The answer is G-E Alnico, one of the most powerful magnet materials in the world. Special Alnico assemblies have been designed to lift as much as

Pouring cast G-E Alnico

4,450 times the weight of the Alnico permanent magnet.

G-E Alnico as originally discovered was a modification of an alloy designed to resist scaling at high temperatures. It consisted of aluminum, nickel, and iron. The magnetic properties of this alloy proved more interesting than its chemical properties, however. Recognizing these properties as probably originating from the solution and precipitation of AlNi compound in iron, the alloy was modified and heat-treated accordingly. The result was the series of permanent magnet alloys which are now called the Alnicos.

G-E Alnico permanent magnets are manufactured by sand-casting, precision-casting, and sintering. Sand-cast Alnico is most economical and is generally used for magnets weighing over 15 grams, unless the magnetic or physical properties of sintered Alnico are required.

Heat treating cast G-E Alnico

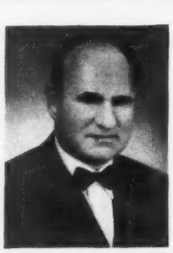
Sintered Alnico is best adapted for mass production of smaller magnets, or for special applications needing more uniform flux distribution and higher physical strength. For shapes that are impractical or impossible to sand-cast or sinter, the precision-casting method may be used to advantage.

But regardless of the method of production, the end is the same . . . shaped pieces of ferromagnetic material which once having been magnetized, show definite resistance to external demagnetizing forces. Unlike quenched steel magnets, G-E Alnico permanent magnets will retain their magnetizing force for very long periods of time . . . actually for centuries with normal use! Truly G-E Alnico magnets are *permanent* magnets.

G-E sintered Alnico magnets are pressed in dies

In the comparatively short time that these powerful G-E magnets have been available, an ever-increasing field for their use has opened up. Today the total production of Alnico in this country surpasses 6,000,000 pounds annually. Tomorrow this figure may be greatly increased as young engineers of vision proceed in research and development of this family of alloys.

G-E Alnico magnets are produced in many shapes



A message to students of metallurgy and metallurgical engineering, from

DR. ZAY JEFFRIES

Vice President of the General Electric Company and General Manager of the Chemical Department

There are many opportunities for further metallurgical research in the highly important field of permanent magnets. We are engaged in the development of better and less costly permanent magnet materials. You who plan a career in metallurgy or chemistry will find the possibilities at General Electric unusual and enticing.

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